TEXTILE RESEARCH

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United States Institute for Textile Research, Inc.

CHARLES H. CLARK, *Managing Editor,*

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Publication Committee

C. H. CLARK, *Chairman* — PROF. E. R. SCHWARZ

DR. ROBERT E. ROSE — DR. A. C. WALKER

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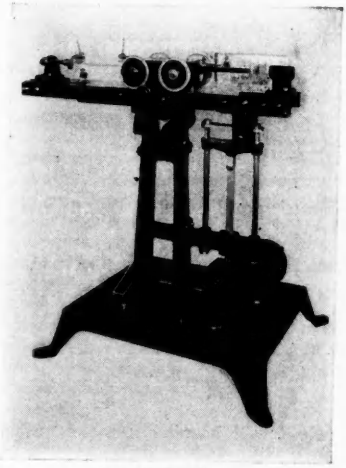

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Notable Research Results Reported at Ninth Annual Meeting

THE annual meeting, research conferences and dinner of U. S. Institute for Textile Research, Inc., held at the Hotel Commodore, New York City, Thursday, Nov. 10, attracted a large and representative attendance of members and guests. To celebrate the start of its ninth year the Institute was enabled to report notable results of two completed researches and the authorization of two new studies. The results of another research, that on textile drying, were considered so important that sponsors were notified by telegraph the day before the meeting that they would be reported and explained personally at a special conference.

As this study and that on the warp sizing of filament viscose rayon, which has just been completed, are co-operatively financed their progress reports are confined to sponsors for a year. For confirmation of the claim that results received by sponsors to date are important and satisfactory the Institute can merely point to the fact that a majority of the sponsors of both studies have renewed for another year.

The special conference of sponsors of the textile drying research was attended by representatives of 24 of the 31 sponsoring companies, and the latest results of the study were reported by Dr. A. C. Walker, chairman of its Administration Committee, who is associated with Bell Telephone Laboratories.

The open conference, called by the Research Council at the request of present sponsors of the warp sizing study, to learn whether there would be sufficient financial support for a study of the warp sizing of cotton and spun rayon, attracted a representative audience of some 75, a majority of whom by rising vote requested the Institute to undertake its organization, financing and conduct, the latter at a southern laboratory and in southern mills.

Completed and authorized researches whose reports are public are both economic studies. The completed economic research

was published in book form last summer and entitled "Vertical Integration in the Textile Industries." It was organized by the Institute's committee on economic research, of which Mr. F. S. Blanchard of Pacific Mills is chairman, and conducted under the committee's auspices by the Wharton School of University of Pennsylvania. It was wholly financed by the Textile Foundation, and the directors of the latter have authorized another study, similarly organized and conducted, on the subject of "Textile Inventory Policies and Statistical Guides." This, like the former economic study is to be conducted by the Wharton School and has the endorsement of the heads of the Cotton-Textile Institute, the National Association of Wool Manufacturers and the Association of Cotton Textile Merchants of New York, who serve with the Institute's committee in an advisory capacity.

Attendance at the annual dinner, as well as at the morning and afternoon meetings, undoubtedly would have been much larger had not the following three-day holiday been a counter attraction for many. Members and guests present at the dinner numbered 72 as compared with a usual group of 125 to 150. The speaking was confined very closely to subjects pertaining to new and completed research programs, and to plans for a broadened and more efficient research policy. There were only two guest speakers, and they are engaged on an economic project of the Textile Foundation and the Institute: Dean Joseph H. Willits and Dr. Alfred H. Williams of the Wharton School of Finance and Commerce, University of Pennsylvania. The other speakers were President E. H. Killheffer; W. E. Emley, chairman, Research Council; and F. S. Blanchard, chairman, Committee on Economic Research.

Directors and Officers Elected

All officers of the Institute were re-elected. Directors elected for a term expiring in 1941 were as follows: Fessenden S. Blanchard, Dr. F. Bonnet, Erb. N. Ditton, Alban Eavenson, Ernest N. Hood, Prof. Louis A. Olney, A. M. Tenney, the President *ex-officio*. The new members are Dr. F. Bonnet, American Viscose Co.; Erb N. Ditton, Gotham Silk Hosiery Co.; and A. M. Tenney of A. M. Tenney Associates.

In addition Dr. A. C. Walker of Bell Telephone Laboratories, and chairman of the Administration Committee for the Institute's drying research, was elected a director for a term expiring in 1940, to succeed Dr. Harold DeW. Smith, resigned.

Members of the Executive Committee elected are as follows: John Bancroft, Jr., Earl Constantine, Alban Eavenson, Ernest N. Hood, Robert E. Rose, Edward R. Schwarz, Douglas G. Woolf, the President, and the Chairman of the Research Council, *ex officio*. The new members are Earl Constantine, president, National Association of Hosiery Manufacturers, and Douglas G. Woolf, editor, *Textile World*.

New Members Elected

The following members were elected at the meeting of the Board of Directors: Contributing: Jos. Bancroft & Sons Co., Wilmington, Del., John Bancroft, Jr., Pres.; Dr. Harold DeW. Smith, Treas., A. M. Tenney Associates, New York, N. Y. Annual: The Bristol Co., Waterbury, Conn., L. G. Bean, Sales Mgr.; Robert H. Brown, Parks-Cramer Co., Fitchburg, Mass.; S. Y. Daun, N. C. State College, Raleigh, N. C.; Foxboro Co., Foxboro, Mass., A. W. Chase, Textile Div.; Dr. E. B. Helm, Industrial Rayon Corp., Cleveland, Ohio.; J. P. Stevens & Co., Inc., New York, N. Y., J. B. Goldberg.

Minutes of the Annual Meeting

PURSUANT to a call issued Oct. 27 the annual meeting of U. S. Institute for Textile Research was held at the Hotel Commodore, New York City, Thursday, Nov. 10, and was called to order by President Killheffer at 11 A.M. The Secretary having reported that a quorum was present in person the President declared the meeting ready for action upon the following agenda:

1. Minutes of last meeting (May 24, 1938).
2. Report of Board of Directors.
3. Report of Treasurer.
4. Report of Auditor.
5. Report of Budget Committee.
6. Report of Secretary.
7. Report of Research Council.
8. Report of Nominating Committee.
9. Election of Directors.
10. New Business.

1. The minutes of the last meeting (May 24, 1938) having been published in TEXTILE RESEARCH and received by all members, they were accepted without reading and ordered filed.

2. The annual report of the Board of Directors (published in this issue on another page) was read by the President, and upon motion duly made and seconded it was accepted and ordered filed.

3, 4. Instead of calling for the report of the Treasurer, which in accordance with an order of the Board is published on another page of this issue, the President called for and read the report of the Auditor, the letter accompanying it and certifying to the accuracy of the Treasurer's accounts being as follows:

Report of Auditor

November 5, 1938.

To the Board of Directors,
U. S. Institute for Textile Research, Inc.,
65 Franklin St.,
Boston, Mass.

Dear Sirs:

I have examined the cash book, bank records and approved vouchers of United States Institute for Textile Research, Inc., for the fiscal year ended September 30, 1938, and certify to the accuracy of same as shown by the records and detailed in the following exhibits:

Exhibit "A"—Cash Statement—Current Fund—Year Ended Sept. 30, 1938.

Exhibit "B"—Cash Statement—Permanent Fund—Year Ended Sept. 30, 1938.

Cash receipts as charged have been duly accounted for, and disbursements substantiated by the cancelled paid cheques, bank charges and vouchers presented. The closing bank balance was reconciled with the cash book with reservation for outstanding items.

Attention is drawn to the fact that the Board of Trustees should have the custody and management of the Permanent Fund as provided in Article IV, section (2) of the By-Laws.

According to the Cash records and vouchers, Drying Equipment amounting to $989.00, was purchased during the year under audit. Attention is drawn to the necessity of having this equipment insured if title to same rests with the Corporation.

Respectfully submitted,
(signed) ROBERT DYSART

The President having asked Chairman Emley of the Research Council as to whether or not the drying equipment mentioned by the Auditor was covered by insurance, the latter and Chairman Walker of the administration committee for the study stated that it was not insured, but that they would investigate the matter and report to the Executive Committee. There being no further comments the President ordered that the Auditor's report be considered as the Treasurer's report and that both be accepted and filed.

Report of Budget Committee

5. Chairman H. DeW. Smith of the Budget Committee read his report after noting that the other two members of the Budget Committee (Messrs. Blanchard and Clark) had not had an opportunity to review the report and that he therefore accepted full responsibility for it. He also noted that his figures were not in all cases in agreement with those of the Treasurer's report, as some of his work had been done before the Treasurer's figures for the end of the fiscal year were available. He recommended that a copy of the report be sent to every director for study, and when thus submitted it will be accompanied by detailed figures of operating funds, research project funds and annual expenditures and receipts for the last four years. All of that data in less minute form are contained and commented upon in the body of the report which will be found on another page of this issue.

Discussion having been called for, Chairman Walker of the Administration Committee for the drying research stated that he was glad to report he was in touch with a company which was willing to contribute certain additional equipment that would be needed by the laboratory, and that it was unlikely that any additional expensive apparatus would be needed during the current research year.

Dr. Smith called attention to the fact that for the first time in this country the Institute had collected from the industry for co-operatively financed research a total of $18,000. While this was but a fraction of the total sum that should be expended by the industry for research, he considered it a hopeful sign of the industry's growing interest in research. There being no other discussion it was duly moved, seconded and

> Voted: That thanks be extended to Chairman Smith for his excellent presentation and that his report be accepted with the understanding that it be submitted to all directors for further study before being filed.

6. The Secretary stated that he had little to add to the annual report of the Board of Directors, but that if there were any questions regarding the work of his office he would be pleased to answer them. There being none the President then asked for the report of the Research Council.

Report of Research Council

7. Chairman Emly stated that he always feels somewhat embarrassed when called upon to report for the Research Council because usually everything that he might say regarding its work has already been said in the report of the Board of Directors. Furthermore, the ruling that confines to sponsors of co-operatively financed researches all results that are not more than a year old prevents disclosure of important results for the warp sizing research, which is now practically completed, and a valuable result of the textile drying research which, he stated, would be reported confidentially at a special meeting of the sponsors that afternoon.

He was pleased, however, that the Institute has one type of research work which is conducted in collaboration with the Textile Foundation and is wholly financed by the latter, all reports of which are published; these are economic researches, one of which, a study of "Vertical Integration in the Textile Industries" was completed and published last summer, while another, similarly conducted and financed, on the subject of inventory

policies has been authorized. Chairman Blanchard of the Institute's Committee on Economic Research, is to report on both of these studies at this meeting and at the dinner this evening. Mr. Blanchard's report will be found on another page of this issue.

The warp sizing project, which has been in progress since 1935, and has been financed on a 50–50 basis by the Textile Foundation and Institute co-operators, will in the future have to be financed wholly by the Institute. This is in line with the revised policy of the Foundation which restricts its researches closely to those of a fundamental character and expects the industry to finance those researches which have reached or are of applied character. At a meeting of the co-operators in this study, held Sept. 9, to discuss what should be the future of the research after the present program had been completed, Chairman Emley stated that he got a very definite im-impression that the co-operators were well satisfied with results to that date, and were insistent that it be continued on a somewhat different basis. A large part of the first year of the original study was spent in fundamental work in the laboratory on starches. At the request of a majority of the co-operators it was later changed to a laboratory and mill study on the warp sizing of filament viscose rayon and appropriate sizing materials. The co-operators at their meeting Sept. 9 favored extension of the study to the warp sizing of cotton and spun rayon. In line with our usual procedure in connection with the organization of new researches a conference open to all who are interested has been called for this afternoon, and the Research Council and your Board of Directors will be guided by the results of this meeting. It was his opinion that a good deal of the fundamental ground work for the new study would be found in the results of the warp sizing study to date, and would simplify and facilitate the study on cotton and spun rayons.

In closing Chairman Emley stated when a new research is undertaken an administration committee is appointed by the Board of Directors, the first job of this committee being to plan a detailed research program, to recommend a laboratory where the work can be conducted, select a man to do the work and supervise that man rather closely. The committee's work requires frequent meetings and much correspondence. Members of our administration committees have served well and faithfully, have contributed their services and deserve large credit for the results accomplished. He then moved, and it was seconded and without discussion

> Voted: That the Institute record its appreciation and thanks for the valuable services contributed by the administration committees for the warp sizing, the textile drying, and the economic researches.

Secret vs. Public Research Reports

Before taking up the next item of the agenda the President called attention to the fact that the Budget Committee had just emphasized the need of increased membership and income therefrom, while Chairman Emley of the Research Council had shown that the one thing that should be most effective in selling the Institute to the industry and largely increasing its membership must be held confidential to two relatively small groups of research sponsors for a whole year. These are the recent and most valuable progress reports of results of the warp sizing research, and the report of a discovery of the textile drying research that was deemed important enough

to be disclosed to its financial sponsors at a special meeting called by wire on a day's notice. The President stated that this was the first time in the Institute's history that the question had ever been raised as to whether or not it was good policy to keep research results temporarily secret. Possibly this was because no results of such apparent importance had been available before to sponsors of co-operatively financed studies. He thought the subject well worth discussion, and a considerable part of this session and also of the meeting of the Board of Directors was devoted to it. A large number of those who spoke favored publication of all results, but throughout the discussion there was no differentiation between fundamental and applied research, possibly because there would have been general agreement as to public reports of the former. The final concensus of opinion seemed to be that it would be unwise to attempt to adopt any such radical change in policy until sponsors of co-operatively financed studies had been canvassed on the subject. It was then moved by Mr. Freedman, seconded and

> Voted: That a committee of three be appointed to investigate ways and means of securing greater co-operation of the industry in the Institute, bearing in mind that it may be advisable to dispense with secrecy in research reports.

Report of Nominating Committee

8. In presenting the report of the Nominating Committee Chairman Freedman expressed regret that he was obliged to record the resignation of Dr. H. DeW. Smith as a valued director and member of the Executive Committee. Dr. Smith interrupted to explain that he took this step only after long deliberation and with great regret; this was only one of the many association activities that he would be obliged to give up in order to prevent their encroachment upon his increasing business duties. He stated that his interest in the work of the Institute would continue unabated, and noted that this is affirmed in part at least by his transferring from annual to contributing membership, also to the fact that the president of his company, Mr. A. M. Tenney, had been drafted as a director. During and following the meeting regrets were expressed by those present to Dr. Smith on his decision and the resultant loss of his active services.

Chairman Freedman then presented the following nominations of directors for a term expiring in 1941: Fessenden S. Blanchard, Pacific Mills, New York, N. Y.; Dr. F. Bonnet, American Viscose Co., Marcus Hook, Pa.; Erb N. Ditton, Gotham Silk Hosiery Co., New York, N. Y.; Alban Eavenson, Eavenson & Levering Co., Camden, N. J.; Ernest N. Hood, Treas., Old Colony Mfg. Corp., Taunton, Mass.; Prof. Louis A. Olney, Lowell (Mass.) Textile Institute; A. M. Tenney, Pres., A. M. Tenney Associates, New York, N. Y.; the President, *ex officio*. To succeed Dr. H. DeW. Smith, resigned, for a term expiring in 1940: Dr. A. C. Walker, Bell Telephone Laboratories, New York, N. Y.

9. It was then duly moved, seconded and Voted: That the Secretary cast one ballot for the ticket as read, and he having done so, the President declared the nominees elected.

10. The hour being so late when the item of New Business was reached the President invited all those present who cared to do so to join the Board of Directors at their luncheon meeting and many of them did so. The meeting then adjourned at 1:15 P.M.

Annual Report of Board of Directors

YOUR Board of Directors feels justified in reporting to the corporation that the fiscal year 1937–38 was the most resultful in its history from the textile research standpoint. The Institute's purposes are to promote, cultivate and facilitate textile research. As a result of the efforts of your Board and Research Council to perform these services we can point to the following accomplishments:

The completion of an initial phase of the warp sizing study that was started in 1935; also to the fact that a majority of the sponsors of that study have sought the Institute's aid in organizing an extension of the study to cover cotton and spun rayon warp sizing. This is the subject to be considered at the open conference this afternoon.

The refinancing of the textile drying research for its second year. Unlike the warp sizing study, which until now has been financed on a 50–50 basis by the Institute and the Textile Foundation, the drying project was wholly financed by 50 Institute sponsors.

The report in book form of the study of "Vertical Integration in the Textile Industries," that was suggested by and conducted under the auspices of the Research Council's committee on Economic Research and wholly financed by the Textile Foundation. The value of this research to the industry is partially indicated by the fact that more than 1,000 copies of the report have been distributed thus far.

The fact that the Textile Foundation has approved and authorized the financing of another economic study to be conducted under the auspices of the same committee, the subject of which is "Textile Inventory Policies and Statistical Guides."

The Research Council and its various sub-committees will report in more detail at this annual meeting as to results of completed researches, and also as to plans for new studies.

Contributed Services Acknowledged

We again call to your attention the fact that the members of the Council and its sub-committees donate to the industry their services in these connections, as do your directors. We desire also to acknowledge our indebtedness for research aid received from the Textile Foundation, whose directors also serve the industry without pay; to Massachusetts Institute of Technology and the National Bureau of Standards, which have contributed laboratory facilities and services of their staffs; to the Wharton School of Finance and Commerce for the contribution of services in excess of those paid for by the Textile Foundation; to the Pacific Mills for the contribution of facilities for experimental mill research as well as the services of their mill staff; and to the many sponsors of our scientific researches for the donation of supplies, equipment and services.

It is only by reason of these contributions that the Institute is enabled to make available to the industry co-operatively financed research projects and results at a fraction of what would be their cost by any other method to any one mill, or to a group of mills.

The Magazine, Textile Research

In the cultivation and facilitating of research work our monthly magazine, TEXTILE RESEARCH, is playing an increasingly important part. Not-

withstanding the decreased number of Textile Foundation reports available for publication during the year under review, and despite the fact that reports of our own researches more than a year old have not yet been prepared for publication, there was no decrease in the total number of research papers and reports of new research techniques published, nor in the abstracts of technical progress throughout the world. With the aid of the Textile Foundation publication arrangement, which provides for the use of this magazine for reports of Foundation researches, and with the aid of revenue from advertising, it is hoped that TEXTILE RESEARCH will be able to reflect the growth of textile science even more adequately. Aiding in the attainment of the same objective will be the following publication committee, recently appointed by your President: C. H. Clark, Dr. Robert E. Rose, Prof. E. R. Schwarz and Dr. A. C. Walker.

Research and General Expenses Segregated

At the adjourned annual meeting in May the corporation adopted amendments to the by-laws that provide for more efficient operation of the Institute. The purposes of one of these amendments seem not to be clearly understood; we refer to the change in annual dues of "Contributing Members" from $100 to $50. Formerly, Contributing Members paid dues of $100 a year whether or not they desired progress reports of co-operatively financed researches. Now a Contributing membership at $50 is necessary to qualify a member to subscribe to and receive the progress reports of a co-operatively financed research, the individual subscription to which has always been and still is, $100; but formerly subscribers to a co-operatively financed research were given a Contributing membership at no extra cost. At that time all costs of organizing and promoting the financing of these researches were charged against the research fund, with the result that in two instances the warp sizing project had to be refinanced before the close of a research year. In 1937 the administration committee for the drying research protested against this policy, and was upheld by your directors. Research promotional expenses since then have been made an item of general expense, the only income available for which was membership dues, including those of Contributing Members who were not subscribers to any research project, but who contributed for the good of the organization. The number of the latter, plus annual memberships, failed to produce enough revenue to take care of the increased charges against general funds for research promotional work. As a result there was a deficit as of Sept. 30, 1937, and but a small cash balance Sept. 30, 1938.

Under the amended by-laws every dollar subscribed to co-operatively financed researches will be expended in actual research work. The cost of organizing these studies and promoting their financing will be charged to general expenses. The resultant increase in general expenses demands an increased gross income from membership dues, particularly from Contributing memberships.

Require More General Co-operation by Industry

You cannot have a research program of this character without an organization, and that organization must have adequate funds for research

(*Continued on page 45.*)

Report of the Treasurer, Fiscal Year Ended September 30, 1938

Receipts		Disbursements	
Attachment released	$ 1,500.00	Deficit, Oct. 1, 1937	$ 1,093.93
26 Contributing Memberships	2,600.00	Salaries	4,500.20
176 Annual Memberships	1,760.00	Rent	360.00
Magazine, TEXTILE RESEARCH	3,974.99	Magazine	2,748.35
Miscellaneous Receipts	700.00	Office Expenses and Misc.	1,722.08
Warp Sizing Research	5,327.40	Warp Sizing	5,470.52
Drying Research	3,400.00	Drying Research	4,382.78
	$19,262.39		$20,277.86
Balance Oct. 1, 1937		**Balance Oct. 1, 1938**	
Warp Sizing	$ 1,298.32	General Funds	$ 110.43
Drying Research	3,602.09	Warp Sizing	1,155.20
	$24,162.80	Drying Research	2,619.31
			$24,162.80

Warp Sizing Account

Balance, Oct. 1, 1937	$ 1,298.32	Expenditures	$ 5,470.52
Receipts	5,327.40	Balance, Oct. 1, 1938	1,155.20
	$ 6,625.72		$ 6,625.72

Drying Research Account

Balance, Oct. 1, 1937	$3,602.09	Expenditures	$ 4,382.78
Receipts	3,400.00	Balance, Oct. 1, 1938	2,619,31
	$ 7,002.09		$ 7,002.09

Balance Sheet Sept. 30, 1938

Cash, Second National Bank	$ 3,884.94	Permanent Funds	$ 2,000.00
Cash, Salem Savings Bank	1,263.25	Interest available for use	548.89
Cash, Salem 5¢ Saving Bank	1,285.64	General Funds	110.43
	$ 6,433.83	Warp Sizing	1,155.20
		Drying Research	2,619.31
			$ 6,433.83

(*Continued from page 43.*)

promotional work. Your budget committee will emphasize this as one of the Institute's most important problems, and one that must be solved by more general co-operation of the industry as Contributing Members if we are to function efficiently.

Your Board and Executive Committee held six meetings during the year under review, and devoted more time to your affairs than during any previous year. While we feel that substantial progress has been made, and that we are more efficiently organized than ever before, we cannot overlook the fact that our progress is disproportionate to the time and energy contributed by your Board, your officers and your most active members.

Report of Budget Committee

Dr. H. DeW. SMITH, Chairman

AS the other two members of the budget committee have not had an opportunity to review this report, the chairman accepts full responsibility for it.

Recommendation No. 1. It is earnestly recommended that a copy of this report be sent to every director and officer for study because the continued existence of the Institute depends upon building up an active interest in it by means of a steadily increasing membership. A table giving approximate yearly income and expenditures from 1934–1938 will provide a perspective for the study of this report.

Last year the estimate of income prepared by your budget committee was based on expected increase in memberships and other sources of income. The comparison of the budget estimates and the actual figures for the year ended Sept. 30, 1938, is as follows:

	Budget Estimate	Actual
Total Income	$25,294.50	$23,506.49
Total Expenditure	22,146.36	19,301.38
Apparent Balance, Oct. 1, 1938	$ 3,148.14	$ 4,205.11
Pledged for Research Projects not completed on Oct. 1, 1938	3,334.00	3,039.37
Net Balance, Oct. 1, 1938	$ −185.86	$ 1,165.74

Because this favorable showing was based on economies in operating the research projects and on the release of an attachment of $1500 during the year rather than in the vitally necessary increase in memberships on which last year's budget was based, the current budget is based on actual memberships and advertising income in sight on Oct. 1, 1938, and is

divided in accordance with the recent action of the Board of Directors into (1) General Operating Funds, including (*a*) office expenses, (*b*) publication expenses; (2) Drying Research; (3) Warp Sizing Research, as follows:

	Estimated Income	Estimated Expenditure		Estimated Balance Sept. 30, 1939
(1) General Operations				
Balance Oct. 1, 1938	$ 586.43	Unpaid bills Oct. 1, 1938	$ 317.45	
(a) Annual and Contributing Memberships	3,580.00	Office	4,333.33	
(b) Publications	4,625.00	Publications	5,666.67	
	$ 8,791.43		$10,317.45	−$1,526.02
(2) Drying Research Including balance Oct. 1, 1938	2,794.31	Drying Rsch.	3,500.00	−705.69
(3) First Warp Sizing Rsch. Balance Oct. 1, 1938	1,155.20	1st Warp Sizing Unpaid bills	420.06	+735.14
	$12,740.94		$14,237.51	−$1,496.57

Although the totals for all Institute funds are as noted, the research funds are not to be drawn on for general purposes and, therefore, the three funds must be considered separately.

(3) First Warp Sizing Research

This project was terminated Oct. 1, 1938, and shows an estimated balance after payment of outstanding bills of $735.14. In 1937, $455 was transferred from General Funds to Warp Sizing Funds by direction of the Executive Committee.

> *Recommendation No. 2.* That the Treasurer be authorized to transfer $455 from the Warp Sizing balance back into General Funds and that the final balance (approximately $280 plus possible salvage value of apparatus purchased for this research) be credited to the Second Warp Sizing Research, if organized; otherwise that it also be transferred to General Funds.

(2) Drying Research

The cash balance on Oct. 1, 1938, of $2,619.31, plus additional receipts in sight of $175, should carry this project to July 1, 1939, at the current

rate of expenditure with no allowance for additional equipment. The Research Council desires to carry this project to at least Oct. 1, 1939, and the very fruitful results which have been obtained during the past few months and which are to be discussed with the present co-operators at a meeting today, support the wisdom of this aim.

> *Recommendation No. 3.* That the Secretary be given all posible aid in securing seven additional co-operators to the Drying Research in order to carry the current program to Oct. 1, 1939.

(1) General Operations

The estimated expenditure for the current fiscal year should not be cut if the Institute is to carry out the purpose for which it exists. Rather should it be increased. *Therefore, additional income must be promptly provided* from advertising and from memberships.

During the current year the Board of Directors authorized the acceptance of advertising in TEXTILE RESEARCH and a start has already been made.

> *Recommendation No. 4.* That the Secretary be given all possible aid in securing advertising in the Institute's journal TEXTILE RESEARCH toward a goal of five full pages and six professional cards to run for a full year. This would add $2,300 to the present income from advertising.

Memberships

In last year's budget report it was pointed out that the policy which had been developed in connection with contributions to research projects was tending to shut off the general funds without which the Institute cannot continue to exist. Since then the By-laws have been changed so as to provide a general contributing membership at $50 yearly which, with the annual memberships at $10 yearly, must provide the backlog of funds for General Operating Expenses. The current transition from the old contributing membership at $100 which could be earmarked for a research project and, therefore, withdrawn from the General Fund, and the present contributing membership at $50 with additional contribution required for those who wish to participate in research projects, has intensified the financial problem for this year.

When all contributors are on the new basis, the income for general funds should be adequate and will grow as the Institute's activities grow.

The immediate urgent need is to increase both annual and contributing memberships.

The table on memberships which was given in last year's budget report is reprinted here with the figures for Sept. 30, 1938, added.

Year	Life Members	Net Annual Members *	Contributing Members Total	Contributing Members Available for General Fund
1931	2	99	35	35
1932	2	115	36	36
1933	2	112	29	39
1934	2	209	28	
1935	2	208	70	
1936	2	194	69	
1937	2	194	112	36
1938	2	188	84	26

* Omitting complimentary memberships donated in 1932 and 1933 by the Chemical Foundation.

Judging from the statie condition of the annual and of the old general contributing memberships, the Institute, despite its very creditable record in the actual financing and the conduct of research, has not yet found how to vitalize its aims and win the increasing support which it must get in order to carry out its purpose.

> *Recommendation No. 5.* That an active campaign be undertaken to obtain new annual and new contributing members.

The increase in income from memberships which is vitally necessary to put the Institute on a sound basis is $2,500. This would require 50 new annual members ($10) at $500, and 40 new contributing members ($50) at $2,000.

The Committee has not included any figures for a possible new warp sizing research because the undertaking of this depends on the results of today's meeting.

Respectfully submitted,
HAROLD DEW. SMITH, *Chairman.*

"*THE formation of the United States Institute for Textile Research a few years ago has filled a much needed want in serving as a clearing house for information on research. Their monthly publication brings to the industry a concise statement of the scientific progress that is being made. Their plan of co-operative research on problems too large to be financed by any one mill promises continued advance.*"—**Russell T. Fisher in** *Daily News Record*, **Jan., 1937.**

Study of Cotton and Spun Rayon Warp Sizing Voted by Open Conference

THE open conference, called by the Research Council at the request of sponsors of the warp sizing study to consider whether it should be reorganized for an investigation of the warp sizing of cotton and spun rayons, was called to order in the West Ball Room at 2 P.M. with an attendance of 75 members and non-members. Manufacturers and their representatives predominated, but the allied trades also were well represented. Chairman W. E. Emley of the Institute's Research Council presided, and the discussion was led by Harold M. Chase, research director, Riverside and Dan River Cotton Mills, Danville, Va., and Fred G. La Piana, Stein, Hall & Co., New York, N. Y. They were followed by Wright Bolton, agent Rayon Div., Pacific Mills, who has been chairman since 1935 of the administration committee for the warp sizing research, Dr. J. B. Quig, of E. I. du Pont de Nemours & Co., Rayon Division, a member of that committee, and Dr. W. E. Yelland, the director of that research, who is now with the research laboratories of Corn Products Refining Co.

In opening the conference Chairman Emley spoke in large part as follows: "The meeting this afternoon is called to discuss the possibility, desirability and advisability of continuing our investigation of the sizing of warp yarns. I presume that all of you are aware of the fact that work on this subject has been under way for the past three years. The first year of this work was devoted to finding some fundamental facts, studies being necessarily confined to the laboratory. Then when we had those facts at our command we were fortunate in being able to take the work to the mill.

"At that time the major problem seemed to be in the sizing of filament viscose rayon yarn with gelatin. Those are the materials that were selected for the beginning of the work. I cannot say that the work has been completed. A research problem is never completed, but at least the work has been carrid on to a good stopping place.

"Owing to the fact that the work was financed under agreement with the co-operators that the detailed results would be confined to them for a year, I am not at liberty this afternoon to give you many of those details. I can, however, say that at a meeting of the co-operators held in New York on Sept. 9 those who were interested in that combination of gelatin on viscose filament rayon expressed themselves as being very well satisfied with the accomplishments to date.

"There were, however, a number of co-operators who were not interested in either filament rayon or gelatin. The discussions seemed to center around the use of starch size on cotton yarn, and possibly of both starch and gelatin on spun rayon. Before undertaking a continuation of the program, however, it has been thought advisable to get the advice of the industry, the people directly concerned, to see whether or not that is the problem before us.

"Is it worth while to undertake research work to improve the methods of sizing cotton warps and spun rayon warps, or have you any more im-

portant problems to suggest? That is the purpose of this meeting this afternoon. In order to place the matter before you rather fully we have asked Mr. Chase to present it from the cotton mill man's point of view."

Messrs. Chase and La Piana emphasized the industry's need of a scientific study of cotton and spun rayon warp sizing, but hoped that the basic facts made available by the old sizing research would allow the new project to be confined closely to the solution of practical mill problems. They also strongly favored the conduct of the new study in southern mills and laboratory. Their papers are published herewith.

Messrs. Bolton and Quig believed that the generally satisfactory results of the completed phase of the warp sizing study should aid materially in selling the new research to the industry, but regretted that the contract with sponsors, which gives them sole use of results for a year, prevented them from making such results public. Dr. Yelland then gave an outline report of some of the results of the completed study that are more than a year old, and noted that a large part of the results of laboratory and mill study would be applicable in the new study, and should aid in producing valuable results much earlier than if they were not available. An abstract of his remarks and also of those of Messrs. Bolton and Quig follow on another page.

After Dr. Yelland's remarks the meeting was thrown open for questioning and discussion, the Chairman promising that speakers would not have their names made public, although a stenographic report would be taken for the use of the Research Council.

While discussion was quite general and disclosed several problems not previously mentioned whose study should be covered in a research of the character proposed, it was in large part merely an extension and endorsement of the suggestions of Messrs. Chase and La Piana. One of the new problems suggested for study was the sizing of dyed warps, the proposer calling attention to the difficulty of getting even size penetration on warps containing white yarns and yarns dyed, say, with sulphur black, indanthrene colors, etc. It was agreed that the solution of this problem would be worth the whole cost of the research to some mills.

The recommendation of co-operators in the old warp sizing study that the new study be conducted in the South, was endorsed by Messrs. Chase and La Piana, and apparently was accepted unanimously by those present. One northern manufacturer when asked to express an opinion stated that it made little difference to him whether the research was in the South or North, provided it is headed by the right men.

Basis of Research Financing

The Chairman then stated that, while he assumed that most of those present understood the method pursued by the Institute in organizing and financing co-operative researches of this character, it might be well to outline it. If this meeting endorses the request of the co-operators in the old warp sizing study that it be extended to cover cotton and spun rayon, then we must learn whether you can assure us of sufficient financial support to warrant us in trying to complete the financing and undertake its organization. Based on previous experience of the Institute in the conduct of similar studies we shall need at least $5,000 a year for this research. This means that we shall need at least 50 sponsors at $150 a year each.

Of that individual payment, $50 is for a so-called "Contributing Membership" in the Institute, the income from which will be used for expenses of promoting the financing of the project and for general expenses of the Institute. Only "Contributing Members" have the privilege of subscribing to and securing the progress reports of co-operatively financed studies. and those reports are confined to sponsors for a year. Every dollar of the $100 subscriptions is used for research expenses, for salaries of the director and assistants, for equipment and supplies, and for committee traveling expenses. Committee services, laboratory facilities and a considerable part of supplies and equipment are expected to be donated, as they have been in other researches of this character. In other words, each subscriber to this project gets for a year at $150 a research costing much in excess of $5,000.

We shall want you to suggest members of the administration committee which will have the responsibility of its conduct and finances. We shall want you to suggest where it shall be conducted. We shall want you to say whether or not it shall be organized, and indicate whether you or your company will become a sponsor.

Research Favored Unanimously

The Chairman then asked those present to indicate by a voice vote whether they favored or opposed the undertaking of the study, and declared the vote unanimous.

He then noted that several of the southern textile schools had offered their facilities for the study, and asked those present whether they cared to express a preference, noting that it would be desirable to have the laboratory, the mills conducting experimental work, and the homes of members of the administration committee within sufficiently easy traveling distance to allow frequent conferences. The only recommendations that followed named the textile schools at North Carolina State and Clemson, the opinion being expressed that either would be sufficiently convenient to mills in the Carolinas which might co-operate.

Chairman Emley then stated that it was the understanding that if the work is to be conducted in the South the administration committee having charge of it should be made up of southern men who may have close contact with it and with each other and asked for discussion and nominations. Mr. Chase of Riverside and Dan River Cotton Mills being nominated stated that, while he appreciated the compliment, he thought selection of the committee should be left to the Research Council. This was evidently the judgment of those present for only one other name was mentioned as a possible member of the committee.

During the progress of the discussion several who had not been sponsors of the old warp sizing research had indicated that their companies would support the new study, and it was now moved, seconded and voted that all who are ready to pledge the support of their companies, or will recommend to their companies that they support the research, shall signify same by rising. The number standing up was 22.

Secretary Clark, who has the responsibility of securing sponsors for co-operatively financed researches, stated that in advance of the meeting ten of the co-operators in the old study had paid their contributing member dues toward the new study, and while several were among those who had

just stood up, he estimated that it was safe to consider half of the needed funds as promised.

Question of Secret Reports

The Chairman having asked if there was any further discussion President Killheffer stated that prior to adjournment he would like to question those present as to whether they considered necessary or desirable in the financing of co-operative researches the restriction to sponsors for a year of progress reports and results of the research. This subject had been discussed at the morning meeting, and would be submitted to a committee for further study before attempting to come to a decision. The restriction to sponsors for a year of these reports and results may be necessary to attract the needed support, but it is a serious handicap to the Institute in securing new members, and in promoting new researches. If we could make public immediately the valuable results of the old warp sizing study and of the current textile drying study we would have the strongest kind of sales material for interesting the industry in membership and for subscribing to our co-operatively financed studies.

While the majority of those who took part in the following discussion felt that secrecy was a mistake and unnecessary, there were several who thought that this bait might still be needed, and practically all agreed that research co-operators who had been sold on the secrecy basis should be thoroughly canvassed before any change is made.

There being no further discussion the Chairman expressed his appreciation for the attendance and the interest shown, and promised that the opinions expressed will have the careful attention of the Research Council. Adjournment was at 4:35 P.M.

Evaluation of the Proposed Research

By HAROLD M. CHASE

THIS is an open discussion on the subject of the warp sizing research which you have sponsored for the last three years, with special reference to the desirability of continuing it. It is hoped that everyone present will contribute to the discussion and that we shall have not only the views of those who have profited by the work that has been done in the past but also of those who hope to profit by its continuation.

As you all know this research has been devoted thus far principally to the sizing of warps for the rayon weaving industry. Personally, I have had very little contact with this branch of the industry, but from a careful reading of the progress reports I would say that the results have been worth the cost of the research many times over. A complete survey has been made of the properties of rayon sizing materials. This has been supplemented by very extensive practical weaving tests under mill conditions. The comparison of different sizing materials with reference to their money value must have pointed the way in some cases to considerable savings. I hope we shall have further expressions of opinion on this subject by those who are in a position to know more than I do about it.

On one point I feel better qualified to speak. The development by this research of a satisfactory micro-photographic method of determining

the distribution of gelatin size is something which would have cost any individual manufacturer far more than the cost to him of the entire research. This method has placed in his hands a means of knowing exactly what is going on in his sizing operation. It is true that not all manufacturers have at their disposal the means for making this determination, but I shall endeavor to show a little later on how this difficulty may be overcome easily.

Those of us who are interested in cotton and spun rayon yarns rather than in filament rayon yarn have followed the progress of this research with interest; I may say with patient interest. We hope that the time has come when equivalent results can be obtained in cotton and spun rayon sizing. To my mind this problem offers even greater opportunities. We have to deal in this case principally with starch, a product which has been the subject of innumerable physical and chemical researches, but which has received by comparison very little systematic study in regard to its practical application to weaving. Expert practical slasher men have accomplished splendid results in specific cases, usually by virtue of long experience and by methods of trial and error. But the time has come when methods of trial and error will not do. In these days it is necessary to change from one class of work to another with increasing rapidity. Failure to design a satisfactory sizing mixture spells disaster. A complete and fundamental knowledge of the properties of sizing materials under any and all conditions is necessary to avoid this and that is something which few men possess and fewer still are in a position to learn by themselves.

In early stages of the Institute's research program a very considerable amount of work was done on the properties of starches and their modifications. This is covered by the first three progress reports. From a study of these reports and other researches along similar lines I feel certain that it is possible to produce from starch an almost perfect sizing material, provided however that its application under varying conditions is thoroughly understood and subject to reasonably perfect control. It is along these lines that research is needed.

I certainly hope that you will decide to continue this research. The cost to individual co-operators is small compared with the benefits which are sure to result. If it is continued we should all come forward with our best suggestions for making it the outstanding investigation of the textile industry. For my part I would suggest that one of the first essentials will be to segregate both slasher and looms close to the laboratory so that all conditions such as speed of operation, speed of stirring, conditions of cooking, temperature, humidity, etc., can be controlled with an exactness comparable with laboratory control. In this way those operations which require special attention can be distinguished from those in which a greater variation is permissible.

I stated that I would endeavor to show how the difficulty of making highly technical tests such as microphotographs could be easily overcome by the individual co-operator. I would propose that a certain amount of consultation service be furnished to co-operators by the research laboratory. For example, if a co-operator wished to have a microphotograph or any other test made of his yarn and was willing to describe the conditions under which it was sized, it could be furnished him free of charge or at a nominal cost. In this way the research on filament rayon, which will

undoubtedly be continued by the individual co-operators, would go on hand in hand with that conducted on cotton and spun rayon. The co-operators would thus secure invaluable technical information promptly. On the other hand the conductors of the research would accumulate a vast amount of practical data as to existing mill practice. As a matter of fact many mills are in a position to make carefully controlled tests. Pooling of these results would not only hasten completion of the research but would benefit all concerned.

Why This Scientific Study is Needed

By FRED G. LA PIANA

THIS discussion is intended to enable the members of the Institute's Research Council to sound out the ideas and sentiments of the textile industry on the opportunity and advantages of continuing the warp sizing research, which has been completed as regards filament viscose warps, by undertaking the study of cotton and spun rayon warp sizing.

The suggested idea of combining the study of cotton sizing with that of spun rayon sizing needs some explanation. We all know that there are radical differences between the nature-made cotton staple and the man-made rayon staple. On the other hand, most of the rayon staple is now being processed in cotton mills and this tendency is increasing daily by leaps and bounds. The same methods and equipment are used to process the two fibres and often they are spun together in the same yarn. While there are problems peculiar to the sizing of spun rayon, many problems are of the same order, if not identical, with the problems encountered in sizing cotton warps. I think that combining this study will eliminate not only the need of duplicating a lot of work, but, at the same time, by contrast, will help us to understand better the behavior of the two fibres, by bringing to light their inherent differences.

In a study of this kind one main object has to be kept in view. Many of the difficulties encountered during the processing of textiles can be met by the practical man on the spot, or can be elucidated by existing methods in testing laboratories. It is no part of the work of the Institute to undertake the study of such problems. On the other hand, where difficulty arises in an unaccountable or unusual way, or from lack of understanding of basic facts, it is clearly desirable that scientific investigations be employed to analyze these problems so that the industry as a whole may be advised and benefited. That the study of cotton and spun rayon sizing belongs to this category of problems is readily admitted by all who know anything about it.

Though a very illuminating research has been conducted on the subject of cotton warp sizing by the British Cotton Industry Research Association in their Shirley Laboratory in past years, it is my opinion that further research is necessary to the complete understanding of the various problems involved; and, besides, some of their conclusions are not applicable to the methods and processes used in American mills.

An adequate idea of the practical value of scientific research is most easily conveyed by examples showing its need and its possible application. In a recent survey of the warp sizing practice in mills weaving wide

sheetings the following facts were brought out: Some mills were using thick boiling corn starch at the concentration of 12 to 14 oz. to the gallon of finished size. Some mills were using potato starch; some were modifying it slightly in cooking by the action of enzymes and using it at the concentration of 16 oz. to the gallon. Some mills were using unmodified medium grade tapioca flours at the concentration of 14 to 16 oz. to the gallon. Some mills were using high grade tapioca flour, modifying it in cooking at the concentration of 14 to 16 oz. to the gallon. Some mills were using a combination of potato starch and sago flour, slightly modified, at the concentration of 14 oz. to the gallon. The cost of the size mixture varied anywhere from 3c to 5½c to the gallon; the amount of size in the sized yarn from 9% to 14%; the weaving efficiency from 85 to 97%; the speed of the sizing machines from 20 to 36 yards a minute. All of these mills were using practically identical sizing machines. Why then all this difference in sizing formulae, size percentage, sizing cost, speed and efficiency?

In analyzing the figures brought out by this survey it was found that the high cost of size was not in close relation with the results obtained, and that in some mills with very low cost of sizing, efficiency was not at all impaired.

Of course, I understand very well that weaving efficiency is not dependent solely on the proper sizing of the warps, but that there are other factors to be taken into consideration too numerous to mention here. On the other hand, the cost of sizing is an important item, and information which will enable the mills to cut the size cost without lowering the weaving efficiency, or to increase the weaving efficiency and the number of looms per weaver by improving their size, ought to be very valuable indeed.

In recommending a research of this type I would suggest that the study be confined to the following points:

1. Study of the ingredients used in the size mixture. This would include the evaluation of starches, softeners, plasticizers, lubricants and binding agents used for this purpose.

2. Study and determination of the best procedure in preparing the size mixture.

3. Study and determination of the best conditions under which the size mixture should be applied to the yarn.

It is clear that the second and third part of this study cannot be carried by laboratory research alone, but must be conducted mainly in conjunction with actual mill experiments. For this purpose the wholehearted co-operation of the industry is needed and especially the co-operation of southern cotton mills who, in the end, would profit more than anyone else from a study of this kind.

As to the first part of the study (that comprising the evaluation of the ingredients of the size mixture) most of this work could be conducted in the laboratory, with some checking up of results by actual mill trials when necessary.

The above statements summarize the arguments for the continuation of the warp sizing research and the application of this study to cotton and spun rayon, and give a general outline to be followed in this research. It is not proposed to suggest how, or on which basis, said research should

be organized or how it should be financed. It is up to the Institute to decide these matters if it is found that the industry is willing and ready to do its share.

Wright Bolton's Remarks

IN reviewing the work that we have done it would seem to me we have gained a considerable experience that might be useful in conducting further research on other materials. I did not come prepared to go into the details of our work, and I think further explanation by Dr. Yelland might be very useful.

However, to summarize it all, we have found very many factors that we were not all aware of at the start. The tests were conducted on a fairly broad scale on the assumption that there was little or no testing data available that could be really depended upon. It was agreed early in the study that all the results would be checked on the actual mill basis and on fairly broad basis. We at times conducted studies on as many as 24 looms and made many discoveries. The first and major discovery, I presume, would be to say that we proved that the general methods of procedure were good sound ones. They were built up on a cut-and-dried basis and I think indicated that the trades supplying materials and equipment had a very good and broad understanding of the problems of the weaving mills.

However, as we went further along we found many variables, and many faults charged to the sizing materials that are chargeable to other things. For instance, in a fairly broad study on 24 looms continuously running we found the equipment much more at fault than the material we used. In other words, it indicated that many of the faults could be charged on careful study to the loom setting, the harness set-up, the reed or the shuttle, and to other little things that would ordinarily be charged to the warp sizing.

In going back to the sizing machine we found variables that we hadn't concerned ourselves with very much; for instance, the very small amount of solids required to size a set of warps for weaving made the consideration of squeeze a very, very important one. Viscosity was very important. The question of some of the conclusions we reached at the point when we stopped seemed to us the most important of all. The question of the slashing machine took on an altogether different aspect when we were able to introduce a moisture control device, indicating that we had not well understood our drying problem. We were able to economize very greatly on the amount of heat required, and proved, I think, that the machine was the weakest link of the chain, and that we could very well afford to buy a little better sizing material.

We might summarize it all by saying that we are in a fair way to be able to compound materials for sizing of filament yarns that would offer a factor of safety against irregular goods, and at the same time be economical. We have left many questions unanswered, questions that I hope this study will help to answer if it goes forward. They are important and can be very useful.

Remarks of Dr. J. B. Quig

PROFITS in the weaving industry today are not large. It is therefore necessary for the weaving industry to have intelligent management.

If an organization today is to have an intelligent and businesslike management which will be successful, there are certain outstanding factors from which there can be no departure. The weaving mill should have:

(1) A technical personnel (at least one man) to handle technical problems or have recourse to other sources of technical advice.
(2) The mill must have a knowledge of its raw materials.
(3) The efficiency of all operations in the weaving mill must be high. This is especially true of loom efficiency.
(4) A high percentage of first grade fabric must be produced as measured by the finished dyed fabric.

There are, of course, other factors which contribute to the success of a weaving mill, but the above suffices for the subject under consideration.

Size is a raw material which has been used from time immemorial in cotton weaving mills. Yet it is doubtful whether the sizing of cotton today is upon a scientific basis.

Why was the rayon industry so slow in recognizing that sizes and the sizing operation should be given more attention? This is partially answered by the fact that there was a period consuming a number of years before the trade understood the properties of rayon. It was perfectly natural that the mills relying upon their own initiative and experience should turn to the sizes and methods of sizing with which they were familiar in the cotton industry.

If we go back fifteen to twenty years we find the following conditions obtaining at that time:

(a) The rayon manufacturer was devoting his time, energy and research to perfecting his process of manufacture. The service sections of the rayon companies were busily engaged initiating rayon in mills, and running down complaints. The rayon manufacturer at that time also felt that the mills, with their experience in the sizing of other fibres could do the job better than they could. It is true that some rayon manufacturers set up sizing equipment in their own plants for instructive purposes and did yeoman work in starting rayon in the weaving industry.
(b) Fifteen years ago there was a greater gap between the converter and the weaving mill than exists today. Like the rayon manufacturer, the weaving mills' time, energy and experimentation was largely consumed in introducing rayon and securing a respectable loom efficiency. If he secured 85% loom efficiency at that time he felt that his looms were running well. If the weaving mill superintendent or executive were asked at that time whether he was concerned with the removal of the particular size he was using he replied that his main concern was weaving and not scouring, dyeing and finishing. The mill was happy if the greige fabric inspection showed a respectable percentage of first grade

fabric. Why take on unnecessary worries? Fifteen years ago there was a margin of profit for the weaving mill which would take care of certain vagaries of misprocessing.

(c) Fifteen years ago the selling agent could always dispose of some spots and yet make some profit for himself and the mill.

(d) There was a time when the dryer and finisher received sufficient recompense per yard of fabric so that he could batch up overnight and give the fabric a good scouring and sufficient time in the dyeing bath.

It suffices to say that the above conditions are not present in the industry today. As necessity is the mother of invention it is also apparent that the necessity for a greater profit is the mother of technological development and research.

In other words, our industry was lethargic in dealing with the rayon sizing situation until we began to see our profits going down in the weaving industry. The advent of acetate rayon in the weaving picture also introduced additional sizing problems.

The more thorough investigation in recent years of the causes of defectively dyed fabric definitely indicated that the raw materials and technique of sizing were factors in this defective dyeing, yet it was apparent that no two laboratories could agree. A questionnaire sent out at the inception of the rayon sizing research was enlightening. There were 19 sets of answers returned from representative companies. As an example let us consider the first question asked, namely, "Considering flat good only, can starch base materials be used satisfactorily as a size?" Eight firms answered "yes," eight "no" and three gave no answer. The answers to this one question are characteristic of the answers to the 40 questions asked, and certainly indicated that our knowledge of sizing materials and techniques could be greatly augmented by the necessary research.

We have not secured the answers to all of the questions propounded in the questionnaire. We have answered some of the principal questions. A number of techniques have been developed which can be employed by mills or laboratories in investigating sizing problems.

The application of size to continuous filament bright viscose rayon and the factors affecting the size application and subsequent drying of the warp have been explored.

Representatives of the chief classes of sizing materials have been investigated in the laboratory and in pilot experiments in the mill.

Suggestions have been made which it is hoped will result in appreciable savings to the weaving mills.

In our opinion one of the most important results of the research has been the stimulation of interest in sizing throughout the entire industry. This interest and cognizance of the importance of sizing has started independent research, has caused weaving mills to scrutizine their sizing materials and sizing operations, and definitely has resulted in better sizing conditions throughout the industry. This is apparent in a diminution of claims arising from sizing throughout the rayon weaving industry.

I think that Mr. Chase's idea of securing the right mill is very important and also his idea of having the laboratory near the mill. The question of a director for the research is a difficult one. The co-operators were divided as to the kind of a director we should have. I am well

pleased with the choice we made. It is my belief that it is better to take a well-grounded, well-educated technical man. If you can secure that type of man who in addition has had practical experience then you have the ideal man, but if you cannot proceure such a man I would prefer to have the man who is well qualified technically. He will very soon pick up the necessary things which he has to find out in the mill.

The administration committee is exceedingly important. I assume that this research is going to take place in the South and, therefore, it would be my definite recommendation that the administration committee come from the South so that these men can get together easily. We have been slightly handicapped in getting together in the rayon sizing research because of the distance between the men making up the committee. We want men on that committee, as I see it, whose practical experience will give the well-qualified technical man all the assistance that he needs. It is very desirable that the administration committee should meet frequently. I was very much impressed by one research that is being done on printing pastes, because the committee, I believe, got together once a week. That would be ideal, and then I am sure the research would move faster and more resultfully.

Dr. Yelland's Statement

MR. CLARK has asked me to give a brief summary concerning some of the techniques and methods that we have developed which might perhaps be capable of being carried over into the field of cotton and spun rayon sizing. In presenting this statement you will understand that, of course, since this is an open meeting, I am restricted to material which has been published in the confidential reports for more than a year. Consequently, some statements may be a very old story to some of you.

One of the more important techniques developed was one mentioned by Mr. Chase; that is the method of determination of size distribution by examination of cross-sections of sized yarn. The sized sample is embedded in gum arabic, or preferably in methyl methacrylate resin. It is then cut in sections of any desired thickness, from two microns up to 50 microns. If the yarn is gelatin sized the sample should be treated before embedding with tannic acid and ferric chloride. If the yarn has been starch sized these cross-sections are best treated after sectioning by means of iodine solution. If the sample has been sized with a mixture of starch and gelatin then separate samples may be treated each way and a sort of composite picture obtained.

In filament rayon this technique showed that the two chief factors in size distribution were the type of size and its viscosity in the size mix. Thin solutions of size tended to penetrate between the filaments more, and the thicker or more viscous solutions tended to coat the outside of the yarn. It was noted that in all cases gelatin seemed to have a greater tendency to coat the filaments of the yarn than to coat the yarn itself, whereas all types of converted starches seemed to collect in aggregates in between the filaments. The starches seemed to have less coating power than did the gelatin. The amount of squeeze exerted by the squeeze rolls or the surface of the rolls did not appear to affect the distribution of the size, although these two factors were very large in determining the total

amount of size applied on the yarn and in determining the drying requirements of the warp.

This method has been used mainly on filament rayon so far but it is quite capable of being applied very directly to cotton or to spun rayon as sized. It will probably be necessary to change the thickness of the sections on account of the twist in the yarn. You will probably have to cut much thinner sections. We worked as a rule with sections of about 25 microns. I think that on account of the twist you will have to work with sections down around 10 microns in thickness. This method will give you perhaps an answer to the effect of twist on size distribution. Little is already known of the effect of twist on the total size pick-up of the yarn.

The general methods which were applied in studying the effect of size on filament rayon yarn can be carried over to the same study on spun rayon or cotton. By that I mean the study of the factors of size application and of their effect on the load elongation properties of the yarn, the cohesion and stiffness properties of the yarn. In the filament rayon study it was found that as long as the breaking strength of the yarn was not materially decreased by the sizing its effect on the weaving properties of the yarn was comparatively small. The residual elongation at the break of the sized yarn was found to be affected much more by the stretch given in slashing than by the type or amount of size on the yarn.

Cohesion and stiffness were also found to be important factors. They were very closely associated, high stiffness being associated with high cohesion. They appeared to go hand in hand. Of course, a high degree of cohesion was desirable for good weaving in order to keep the filaments tied together. The high stiffness, on the other hand, tended to cause tear marks and defects in the finished goods.

The optimum for good weaving conditions is found, of course, when the cohesion is sufficiently high to give you as little balling-up in the loom as possible and yet the stiffness is not yet enough to show up as tear marks and so forth in the grey goods.

These optimum conditions, of course, are different for each mill because each mill has its own abrasion problem in the weave room. The work on gelatin which formed so large a part of the work on filament rayon sizing would probably be replaced by an analogous investigation of starches.

The previous work has shown that if tests are made on mill scale it will be absolutely essential to have as close control as possible, not only during the slashing operation, but also during the weaving. This means you must have size temperature control on the slasher, size level control, etc. We have found that, strangely enough, we are able to keep the size temperature much more constant when the size level is also controlled so that all these things are interrelated. A regain controller or a moisture controller is absolutely essential. Otherwise the warps will come off of the slasher with a wide range of regain; that is, on a filament rayon from less than 1% up to 8%. Manual control is simply not good enough for test conditions. You must have as close control as possible, and that is only possible through the application of as many needed controls as you can get on the slasher.

The Annual Dinner

THE annual dinner was held in the West Ball Room at 7 P.M., with an attendance, as previously noted, of some 72 members and guests. At the head table with President Killheffer were the following: W. Ray Bell, president, Association of Cotton Textile Merchants of New York; Edward T. Pickard, secretary and assistant treasurer, The Textile Foundation; Louis A. Olney, first vice-president of the Institute and chairman, Research Committee of the A. A. T. C. C.; Dean Jos. H. Willits and Dr. Alfred H. Williams of the Wharton School of Finance and Commerce, University of Pennsylvania; W. E. Emley, chairman of the Institute's Research Council, and chief, Organic and Fibrous Materials Division, National Bureau of Standards; Fessenden S. Blanchard, chairman of the Institute's Committee on Economic Research.

Letters of regret from guests who had accepted invitations, and were unable at the last minute to attend because of business duties, were received from Franklin W. Hobbs, chairman, The Textile Foundation; Dr. Claudius T. Murchison, president, The Cotton-Textile Institute; Arthur Besse, an Institute director and president, National Association of Wool Manufacturers, and Earl Constantine, a director of the Institute and president, National Association of Hosiery Manufacturers.

President Killheffer acted as Toastmaster for the speaking program and concluded it with an inspiring address in which he reviewed the dramatic political and economic happenings of the past year, and showed the vital connection between these and textile research, or the need of increased research by the domestic industry. Following his formal address he gratified the curiosity of the audience by explaining briefly the characteristics of the new synthetic yarn "nylon" and allowing those present to examine samples of the material and hosiery made therefrom.

The first speaker was Mr. Emley, and we regret to report that since he was assumed to be speaking from very complete notes no attempt was made to secure a stenographic report of his admirable address, and it will not be possible to publish it in this issue.

The next speaker was Chairman Blanchard of the Committee on Economic Research who commented briefly on the study of "Vertical Integration in the Textile Industries," and then explained in some detail the purpose of the new economic study on "Textile Inventory Policies and Statistical Guides" which is to be conducted under the auspices of his committee and wholly financed by The Textile Foundation. He then introduced Dean Willits and the latter asked Dr. Williams to precede him as the new study would be conducted under his direction. The President's address and Mr. Blanchard's remarks, also a brief outline of what Dean Willits and Dr. Williams were reported stenographically to have said, were as follows:

Another Economic Textile Research

By FESSENDEN S. BLANCHARD

I should like first to make a few remarks about the study of Vertical Integration in the Textile Industries, which was completed last June, As you may remember, this project was recommended to the Textile Foundation by the Committee on Economic Research of U. S. Institute for Textile Research a little over two years ago. The Textile Foundation made a generous appropriation to finance this project and the Wharton School of the University of Pennsylvania was selected to undertake the work. Over 500 companies were interviewed and 23 leading textile associations co-operated in this work. I know of no undertaking which has received more widespread support from all branches of the textile industry.

Although the report was completed only last June, more than 1,000 copies have already been distributed and many favorable comments have come in from members of the industry. The report is full of "meat" and has a great deal of valuable information and suggestions contained in its pages. I certainly hope that all of those here who have not already read it will find an opportunity to do so. I understand a few copies are available after this meeting for those who would like to get a copy. There are also available a few mimeographed copies of a talk which I gave recently before the annual meeting of the National Association of Cotton Manufacturers, in which I endeavored to summarize this report and indicate what seem to me some of the most significant "high spots."

I should now like to make an announcement which I am sure will be of real interest to members of the United States Institute and their guests. The Textile Foundation has just made another generous grant for a new research study which was recently recommended to them by the Committee on Economic Research of this Institute. This project was recommended after very careful study by your committee and has been endorsed by the presidents of the Association of Cotton Textile Merchants of New York, the Cotton-Textile Institute, and the National Association of Wool Manufacturers, whose interest in this subject has been of great aid to the committee in the development of the project. The project has also been approved by the Advisory Committee on Economic Research of the Textile Foundation. I will read the project as it was submitted and approved.

Textile Inventory Policies and Statistical Guides

"The various branches of the textile industry have suffered greatly from the effects of violent fluctuations in buying. These effects have been due, at least in part, to inadequate knowledge of commitments and inventories and sales at each stage in the channels of distribution from mill to consumer. There has been a lack of danger signals, which, by focusing attention on inventory trends, would serve as a warning of approaching trouble and enable better control to be exerted by the various factors in the textile industry. It is one purpose of the report to review what has happened in the past few years in connection with inventories and their effects on operations. Another purpose of the proposed project is to show the degree to which present statistical information is adequate and inadequate, to indicate the relative importance of these factors at any

given time, and to recommend how and wherein such statistical data should be expanded.

In order to accomplish the above, the following specific studies should be included in the research:

(1) A review of inventory trends and policies in recent years, at each stage of marketing between fibre and finished consumer product, covering different major classifications of textiles.

(2) An analysis of such changes as have occurred and their causes and effects upon textile activities, both seasonal and cyclical, and for different types of textiles.

(3) An analysis of the guides now used in formulating inventory policies in the production and distribution of particular products.

(4) Suggestions for improved handling of commitments and inventories based on the above history and analysis.

(5) Suggestions as to what further statistical information is necessary and how it can be obtained, distributed and used—for each major textile classification and at each stage between mill and consumer.''

The Industrial Research Department of the Wharton School has again been selected as the agency to conduct this study. We all feel confident that the completion of the project will be awaited with real interest by the textile industry. It is not only a logical development of much of the work that has gone before, but the history of the past few years gives added emphasis to its importance.

I want to express the thanks of the U. S. Institute for the generosity and far-sightedness of the Textile Foundation in its support of economic research. I should also like to express our thanks for the splendid job done by the Wharton School on the study of Vertical Integration. I am confident that the new project will also be a fine job and will receive the same splendid co-operation from all branches of the industry.

In closing I should like to ask Dean Joseph H. Willits of the Wharton School to tell you something about these economic studies as he sees them. Dean Willits has been honored by a call to a larger and more important field, and next February will assume his new duties as director of the social science division of the Rockefeller Foundation. He will be succeeded as dean of the Wharton School by Dr. Alfred H. Williams, who has kindly consented to speak to us, and I will ask Dean Willits to introduce him.

Dr. Williams' Remarks

DR. WILLIAMS spoke briefly of the program developed by the Textile Foundation for the teaching of economics in textile schools, the text material for which was prepared under his direction and editorship as Professor of Industry at the Wharton School. There are four of these text books under the following titles: Management of a Textile Business, Textile Costing—An Aid to Management, The Marketing of Textiles, and The Textile Industries—An Economic Analysis.

Dr. Williams stated that he wished to present a few words of appreciation on this program of the Textile Foundation which is designed to broaden the educational curriculum of the textile schools. ''I can pay a compliment,'' he said, ''as to the wisdom of the job that is being done; not only in a clearer discernment of the problem, but in its very wise

handling as it took shape. The Textile Foundation made a survey of the work of the 11 textile schools of the country, and the results of the survey seemed to indicate that there were four types of boys being sent into textile industry each year by these schools. First, was the boy of artistic temperament, who was naturally interested in color and design; second, the boy who under other circumstances might have been a mechanical, chemical or electrical engineer, but who was preparing to go into the textile industry to be in charge, perhaps, of the operation of machinery, its set-up, maintenance, etc., a boy who was distinctly of an engineering turn of mind; third, the boy who is interested in the chemical aspects of the industry such as dyeing and printing; fourth, the boy who might be lacking in aesthetic appreciation, but knew something about the value of it, and while he might not get good grades in the technical courses, yet had innate commercial ability and felt interested in general information. The Foundation felt that the training of that latter type needed strengthening, and proceeded to do what it could to stimulate that aspect of the curriculum. It has handled the problem very wisely. It conceived that the most adequate training for management required a broad understanding of economic principles. Some of the textile schools had been sending their boys over to the economics department for this type of training, where they were for the most part under the tutelage of instructors who were interested in economics from an idealistic or theoretical point of view, as they are normally found in most text books.

"The result was that the Foundation and its co-operating textile school deans felt that it would be well to re-orient the teaching of economic theory in terms of the textile industry. A series of four books of this character has been made available to the textile schools for use in the class room. The Foundation attempted no coercion in the preparation of these books, nor with regard to their adoption. There has been a very gratifying response, and one of the leaders in the field of engineering education has been kind enough to say that he thinks the Foundation has started a project which will be of benefit in the teaching of engineering generally.

"As a result of this wise program of the Foundation I think that the industry as a whole can expect the students and graduates of these 11 schools to have a clearer knowledge of economic principles than they otherwise would. While it may be true that economics is not a science in the sense that some of the physical sciences are, yet it is true that one can take a scientific attitude in the field of economics, and if we can send the potential manager into the textile industry with a little more basic training in the field of economics I feel that the Textile Foundation will have done a good job and earned our lasting gratitude."

Dean Willits' Talk

IN behalf of the University of Pennsylvania I want to thank the Textile Foundation and the U. S. Institute for Textile Research for the confidence that has been imposed by them in the Industrial Research Department of the Wharton School, both in inviting them to undertake the study of vertical integration, and now of this further study of inventories. We do appreciate that confidence very much. That isn't because my colleagues in the Industrial Department are interested in the textile

industry and its problems, although they are and deeply. That is sufficient reason, but there is more reason than that. I am sure all of you must have felt as I did when Mr. Emley was talking, with regard to the contrast between the precision and the relative order and predictability in the world of physical sciences, and the confusion and chaos and uncertainty and medley of change that there is in the economic and social world. I am sure you all must have felt that we can't in despair surrender and say the task is hopeless of having greater order and understanding in the business-economic-political world, because if we do then we surrender the field to emotional pretense and propaganda and misconception. All of these things make society unlovely. So we welcome the chance to be associated with the Foundation through the Institute's committee on economic research because we feel that they are working out a program of research in the economic field that has particular significance to the textile industry; perhaps especially significant to you because of the fact that you are not in an industry of large units with great research departments. Being composed of relatively small units the study of complicated marketing and inventory policies is beyond the range of possible attack by the single business. We know of course that a great advantage of our economic system is that so many individual units are developed; but we also know that they have not attacked and do not approach the problems that are too broad for the individual plant to deal with. Fortunately, the textile industry has the Textile Foundation and the Institute and they have had the foresight and ingenuity to plan policies and to seek facts for the industry, just as we are helping by careful selection of problems to single out those issues in the economic field that will most illuminate both the individual jobs and the general situation, so that all will get that keen insight of individual responsibility and common understanding of a general problem that will make for wise direction and management individually and collectively of the textile industry. We at the University are pleased to be one of those permitted to participate in the program that you and the Foundation have planned. We are very grateful to you and thank you for this confidence.

President's Annual Address

By DR. ELVIN H. KILLHEFFER

WE meet this year under different conditions than a year ago—different politically and economically. These dramatic political happenings have wide economic implications: Attempts at appeasement in Europe, which if successful will be more surprising than failure would be. Incidents in the Orient, which formerly were described as conquests. In each of these cases trade opportunities are being shut off so that only the aggressor nation shall have free access to the markets.

As Chamberlain tries to appease Germany by giving her what she wants, so Mr. Hull in this country tries somewhat the same formula, although under a different name.

Doubtless some present in this room tonight think they agree in the main with the Hull theories. All over the United States there are people who commend his ideals. We all in fact applaud the ideals, but in this far from ideal world, do they work?

There is much argument pro and con. In the Scriptures we read the incident where Christ made a blind man see. There was much argument then as to whether the remedy applied was effective or not and as to whether the healer was indeed competent. Much questioning of the man formerly blind finally led to this declaration: "This I know, that whereas I was blind, now I see."

Brushing aside then, in similar fashion, all quibbling, what promises were held out for the trade treaties? Prominent was the claim that the distress of the farmer would be ameliorated by regaining and expanding foreign markets for his products. Discriminations against our trade were also to be eliminated. But neither of these economic results have been realized. Cotton, which is the number one problem of American agriculture, has not been aided. Indeed, other nations are now raising more than ever before and are supplying our former customers. Discriminatory treatment also is perhaps more prevalent than ever before.

The appeal that trade treaties are the road to peace is an emotional one, disclosing bankruptcy in economic justification. It may be shrewd politics to so capitalize on an almost universal desire for peace, but it is a cruel joke on credulous people. We have been making trade treaties now since 1934. Is the world more peaceful today than it was four years ago?

What is being done is to reduce tariff duties, extending the benefits of all the reductions to all nations except Germany. Thus the rapid industrialization of the Orient, with its totally different wage and living standards, is being ignored.

Is this a serious threat to our textile industry? The great influx of goods here and in the Philippines, even without tariff reductions, seems to indicate very clearly just how serious it is.

Any such discussion always brings up the apparent conflict between those advocating internationalism and those believing in nationalism. Usually, when those terms are debated, it is the extreme forms of each that are visualized. Happily, we in the United States are not confronted with the necessity of choosing between them. We can follow instead a course embracing an intelligent nationalism and an intelligent internationalism. I will not stop to define these terms to this audience for I think it is reasonably clear that what I am advocating is a course of moderation.

Let me make another observation and then I shall try to tie these random remarks together. Have you ever considered the vast difference in our living that has come about in the last 75 years or so? That long ago approximately 75% of our population were living on the land and in times of depression could at least sustain themselves. In our present time, only about 22 to 24% live on the land. More than three-quarters of our people have no similar means of sustenance today. This affords some explanation of the tremendous burden of public relief in times of depression. Obviously, the cost of this is an addition to the cost of everything grown or manufactured in the United States.

Now what connection is there between these things about which I have spoken and the subject of textile research? I think the implications are plain. Many of our former foreign markets are being closed to us. This makes the retention of our home market more important than ever. Simultaneously, we follow two courses in the United States which are diametrically opposed to each other. We deliberately make all our costs

higher through shorter hours and higher pay, both of which are desirable. We have constantly increasing taxes which are also additions to cost. At the same time, through reductions in our duties we encourage greater imports from countries having much lower wage and living standards than we have. Thus we jeopardize our position in the one market we should be sure of.

In its investigation the National Economic Committee is very likely to inquire into the condition of industries protected by tariffs. How efficient are they? Is the tariff simply protecting inefficiency? In any such line of inquiry the question of research may be of paramount importance. What is the industry doing in its own behalf? Other nations have broad programs of textile research. Have we?

With or without tariff reductions, we may be heading toward an economy of lower prices. We must seek a way to reconcile or overcome the vast differential in costs between Occident and Orient.

There is a tremendous field for exploration out of which I shall only suggest a few questions to be answered.

What would be possible if cotton could be raised to sell profitably at three or four cents the pound?

Have we reached the ultimate in mechanical handling?

Will there be no more new or novel things?

Is it possible perhaps to devise an entirely new way of making textile fabrics?

This does not even scratch the surface of possibilities for intensive research. Today, facing the new conditions, this is more urgent than ever before.

In closing I can gratify your curiosity, in some degree at least, as to our * recently announced nylon. Let me make one point entirely clear. We do not have a plant to manufacture this product and will not have one completed before the expiration of at least a year. It is hoped that production will start early in 1940. This then is only an opportunity for you to see and examine a new material which is a product of research. It is not cellulose, nor does it contain any cellulose. As the public announcement stated, coal, air and water are the basic materials needed for its production.

In its physical and chemical properties, the textile fibre produced from nylon differs radically from all other synthetic fibres and constitutes the first man-made organic textile fibre prepared from raw materials of the mineral kingdom.

The new synthetic material is the outgrowth of research that has covered the better part of a decade.

Like natural silk, nylon is a polyamide having a protein-like structure. Filaments of extreme fineness can be spun—much finer than the filaments of silk and rayon. The dyeing of nylon presents no particular difficulty. In general it will take dyes used for silk, wool, acetate, and certain of the direct dyes used for cotton or rayon.

* E. I. du Pont de Nemours & Co.

Personal

Dr. E. H. Killheffer, president of the Institute, was elected at the recent annual meeting in Boston of the Home Market Club a member of its executive committee.

* * *

Harold J. Walter, treasurer and general manager of the Uxbridge (Mass.) Worsted Co., and a contributing member of the Institute, was elected president of the Home Market Club at its annual meeting, Nov. 16.

* * *

Dr. Milton Harris, who for several years has been a research associate of the American Association of Textile Chemists and Colorists at the National Bureau of Standards, has been appointed director of research for the Textile Foundation's research associateship at the Bureau. The purpose of this research program is to secure basic data on the physical and chemical properties of textile fibres.

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Fessenden S. Blanchard, chairman of the Institute's committee on economic research, has been appointed a member of the Textile Foundation's advisory committee for economic research.

* * *

Dean Jos. H. Willits of Wharton School of Finance and Commerce, University of Pennsylvania, under whose direction was conducted the study of "Vertical Integration in the Textile Industries," has resigned, effective Feb. 1, 1939, to become director of the Social Science Division of Rockefeller Foundation. He will be succeeded by Dr. Alfred H. Williams at the Wharton School.

Obituary

John White Arrington, president, Union Bleachery, Greenville, S. C., and a director of U. S. Institute for Textile Research since its organization in 1930, died at his home in Greenville, Nov. 14, following a long period of declining health. He was born in Warrenton, N. C., Feb. 28, 1866. His family moved to Richmond, Va., where, before he was twenty-one, he became treasurer of the Old Dominion Cotton Mills, one of the first southern textile mills. In 1895 he built the Edna Cotton Mills, Reidsville, N. C., and served as its treasurer. In 1904 he was prevailed upon to assume the management of the Union Bleachery, which at that time had not proved successful. Not only did he demonstrate conclusively by his pioneering work that textile finishing could be conducted successfully in the south, but in the thirty-four years of his management the plant was expanded to five times its original size. He was not only one of the country's leading textile men, and a director of several textile associations, but was a recognized leader in civic, church and social organizations. He is survived by his widow, a daughter and three sons, John W., Jr., Richard W. and Nelson B.

Viscosity of Starch Pastes

The Changes Therein Due to Continued Heating and Stirring, and their Relation to the Sizing of Cotton Yarns

By DR. J. R. KATZ *

A Research of U. S. Institute for Textile Research

Introduction

IT is a well-known fact in the textile industry that in cotton sizing the viscosity of the starch size must be kept fairly constant, if a good, even sizing shall result. Every mill man knows that if his viscosity falls too low, satisfactory weaving will prove impossible. Yet most mill men know little about the causes of these changes in viscosity.

We were aware that viscosity is only one factor in cotton sizing; but we can study only one at a time, and, without doubt, viscosity is one of the most important factors. So, we resolved to begin our research by studying the influence of heating and stirring on viscosity of the size. This decision was indicated also by the circumstance that we had already a good deal of information available on this subject, due to the fact that Dr. M. C. Desai, who contributed to our research as a voluntary worker, had done several months' work on this subject with me, while I was a Baker non-resident lecturer at Cornell University (in the first term of 1934–35).

What must be the leading thought in such a research about starch viscosity changes? Walter A. Nivling pointed out as early as 1924 the importance of the subject and showed the way it had to be attacked. I agree with his fundamental idea. The starch paste consists of a suspension of vesicles with frail, starchy walls, suspended in water or a thin watery solution of starch.[1] Every starch granule swells when heated with water—as Arthur Meyer had shown in 1895—to a vesicle or sac, filled with a rather thin starch solution.[2] W. Harrison, in England, had seen as early as 1907 that a starch paste was a suspension of swollen starch granules; but he seems not to have seen that they are vesicles with a starch wall, filled with a starch solution. He knew that they produce the thickness (the viscosity) of a starch paste.[3] However, Nivling, as I said before, first pointed out in regard to sizing that starch paste is a suspension of such starch vesicles in water or in a thin watery solution; that the high viscosity is due to the large volume occupied by these vesicles; and that the drop of viscosity on continued heating or stirring is due to the breakdown of these vesicles. So, it seemed indicated to study the problem of the breakdown of viscosity combined with microscopic examination, to show how and to what extent the starch vesicles break down through heating and stirring in a

* The late Dr. Katz was director of the Institute's warp sizing study at Massachusetts Institute of Technology until January, 1936.

starch paste, and how this fundamental phenomenon is connected with the drop in viscosity of starch paste. This is one of the tasks we have undertaken in our warp sizing research. We will show how in this way the actual daily experiences in the mills can be understood; in which ways we hope to check the drop in viscosity, and how all this can be applied to the understanding and the improvement of cotton sizing.

It is clear that a liquid made viscous by the presence of innumerable frail walled vesicles must have a tendency to get a lower viscosity.[4] A hot starch size is therefore essentially a liquid which shows a continuous drop (often irregular) in viscosity (in thickness). How much it will have decreased in a given time will depend on how long and how high the bath has been heated, and how much it has been stirred during the time it was kept hot. When such a size bath is not kept exactly in the same way every time, the viscosity will change and change, and may show considerable fluctuations during the day, or from day to day. That is what causes trouble in the mills.

This trouble comes from the fact that if the viscosity of the size bath changes, the amount of starch taken up by the yarn (for a given count of yarn) varies considerably; also the penetration changes. As a rule one can say that the lower the viscosity drops, the less starch the yarn takes up, but the more penetration there will be. Changes of temperature, or changes of concentration also affect these points (conditions of application being the same). These experiences of the practical men are confirmed by the experiments on warp sizing of the British Cotton Industries Research Association and of many textile technicians. In order to keep the yarn evenly sized we must prevent the conditions of sizing (and especially the viscosity) from changing more than within a reasonably wide latitude.

If one does not keep within this latitude (how large it is depends on the kind of yarn and fabric) then the unevenness of the sizing will make itself disagreeably felt in the weaving room. If one loses sight of the importance of even sizing the difficulties may become so great that it gets difficult for the overseer of the weaving room to straighten things out. Therefore, what the textile industry really wants for getting evenly sized yarns is a size bath with (possibly among other things) a really constant viscosity which is neither influenced by heating nor by stirring.

Such size baths can now be prepared—at least in principle. In Germany, polyvinylalkohol (a synthetic product made from acetylene gas) is now widely advertised as a size bath, especially for rayon, but also for cotton. It does not show (as we will see later) any such drop of viscosity on heating or stirring.

Then, why does the industry cling to starch? For the doubly good reason that it is cheap and that it has been used for centuries before the synthetic sizes were being developed. In many respects, moreover, starches are excellently fitted for sizing; for instance, they can be desized with enzymes (for polyvinylalkohol we would not know any such enzyme). But they have this one very undesirable quality: they lose their viscosity rapidly when heated or stirred in the form of a paste. And unhappily this is just the form in which we have to use them for sizing.

Before it was understood why starch size baths are liable to give such disagreeably varying results, the sizing was (as you know) first considered as an art known to the few; to special slasher men (who often had learned it from their fathers), an art which was often kept very secret. At a later

stage of the development it was considered to be a necessary evil, presenting a lot of misunderstood and disagreeable difficulties; and yet not taken seriously enough to be studied systematically.

As the situation stands now it should be taken neither in the one nor in the other way. As a matter of fact, it should be studied scientifically and be basically understood. And, at the same time, as long as we use starch size for cotton the best thing would be if it were supervised by a man able to understand its mechanism, and be compared daily by him with the results it gives in weaving and in desizing. Combining these results that man would be able to learn how to avoid the difficulties. Nowadays in a number of plants there are no adequate means by which the weaver can trace back what is the cause of faulty weaving, so far as it is thought to be due to the sizing. The man we spoke of, however, would be able to put a, b and c together, and to understand how they are connected and frequently to avoid them.

Such a man should preferably be a physicist or a chemist; in every case a man with a good deal more learning than most "slasher men;" at least a graduate of a modern textile school.

He could also take care of a difficulty not yet mentioned: the variability of the starch itself. Potato starch samples can show widely variable viscosity and can change their viscosity a good deal when kept airdry in the warehouse. Starch after all is a product grown in a plant, and not a "chemically pure substance." It has a hidden growth structure in it which determines its properties.

But the very best things cannot always be attained. And let us not stretch a point which for the moment is out of the question (at least in most of the mills) for financial reasons. Let us, first, by a simple and reliable method understand what the cause of the trouble is, then see what can be done best in the present circumstances and within the available limits. This first report will be devoted to an analysis and an understanding of the changes in starch paste when kept warm or stirred. Later reports will continue this line of research till its results can be practically applied.

Determination of the Viscosity in 1% Starch Pastes

It is advisable to begin this line of research with dilute starch pastes, containing not more than 1% starch. Then the sacs to which each starch granule swells are easily visible under the microscope as separate units. As a consequence we can understand much better by experiments what happens in a starch paste when heated or stirred, than when we study the 8–12% solutions actually used in sizing of cotton. Moreover, there is then no strong interaction of adjacent starch granules in moving; each of them moves more as if it was alone in the liquid. As a consequence we can really measure the viscosity, and measure it in a simple and reliable way, whereas in the concentrated starch pastes there is so much interaction between starch sacs that E. Bingham is right in doubting if viscosity masurements have sense, when done in the usual way. The viscosity depends so much on the pressure used, and under the higher pressures the starch sacs break up so much during and through the determination of the viscosity that all our present measurements of these viscosities measure something different from that which we believe to measure. This point I hope to be able to discuss in a later report. But for the time being I wish to remain within safe

limits, and only measure and observe what really can be measured and observed. This means that it is necessary to keep within the limit of low viscosities and small concentrations, where the above-mentioned difficulties do not obscure our investigation and where the individual starch granule can easily be seen and studied under the microscope. Therefore at this time I will only study 1% starch pastes.

In making the starch paste, 1 gram of airdry substance (known content of hygroscopic water) is weighed and mixed with 25 cc. of cold water, so that an even suspension is made showing no lumps. 75 cc. of water are heated to the boiling point, then poured slowly into the suspension (under sufficient, but not too intensive, stirring) giving a homogeneous paste. If there is any non-homogeneity the experiment is rejected and has to be repeated.

A drop of this paste is brought onto a glass slide, covered with a thin glass, then examined under the microscope. Another part of it is used for making a viscosity determination with an Ostwald viscosimeter at a temperature of exactly 25° C.

The remainder of the paste has been transferred meantime (as soon as it had been mixed) to a pyrex glass flask in which it was heated in a bath of boiling water; the pyrex glass flask was provided with a reflux cooler so that the concentration of the paste could not change during the heating. After different intervals of time a sample was taken out of the liquid; it was examined under the microscope and its viscosity was measured at 25° C.

In this way the influence of prolonged heating could be studied. If we measured the influence of stirring at the same time, a glass stirrer was used, driven by a synchronous motor. As the gearing could be changed, different well-defined velocities could be obtained and the number of revolutions per minute exactly known. The results we obtained are graphically represented in curves, all drawn on the same scale. In order not to make this report too long no figures are given.

We may add (although it seems almost superfluous) that only such experiments are described as could be repeated every time with the same results. It is not so simple to get such reproducible results with starch viscosities. But we learned to overcome this difficulty.

The Stable Viscosity of Polyvinylalkohol

Before I begin to describe the changes in viscosity of 1% starch solutions I want to describe the viscosity of 1% solutions of polyvinylalkohol, which does not show any changes in viscosity on heating or stirring. Polyvinyalkohol has the chemical formula $CH_2-\underset{OH}{CH}-CH_2-C\underset{OH}{H}-CH_2-C\underset{OH}{H}-$ etc. Probably its molecule has a chain form and has 50 or more units ($CH_2-C\underset{OH}{H}$), dependent on the degree of polymerization. It is made from polyvinylacetate, which in its turn is made from acetylene gas. It is a new synthetic size, especially recommended in Germany.

A 1% solution of the airdry substance we had at our disposal gave a viscosity about equal to a 1% starch paste made from thick boiling corn starch heated for a few hours. Heated during six hours at 99° C. it kept its viscosity unchanged; stirred with the high speed mixer (2800 r.p.m.) during five hours it remained entirely unchanged. (See Fig. 1). So, here

we have a sizing agent which does not have the undesirable quality which is the weak side of starch solutions.

Why do these polyvinylalkohols behave so much more favorably than starch? Microscopic examination of the solutions shows that there are no vesicles or other visible units which make the viscosity higher than it would be if they were broken down and dispersed. So, the typical complication is lacking which causes the trouble in starch pastes.

Polyvinylalkohol is more expensive than starch. I believe that starch is not yet in danger of being pushed aside by this or some other synthetic substance. But the constancy of the viscosity of synthetic substances is such a great advantage that it seems to me not to be improbable at all that eventually a synthetic substance might be developed which would take the present place of starches in warp sizing. Such synthetic substances can be prepared in every desired viscosity, as their viscosity increases with their degree of polymerization (with the length of their chain-form molecule).

Will the costs not stand in the way of their introduction, since starch is so cheap as compared with synthetic substances? True! But any substance, made in very large quantities, can be made after some time for development for a relatively small price; and we cannot foresee in any way what synthetic chemistry might not be able to accomplish. I personally believe that there lies here a very hopeful field for further research in synthetic polymerizates.

But for the time being starches are the sizing agents generally used for cotton sizing. So we will restrict our further experiments to be described in this report to starch pastes and starch solutions.

Ordinary (Thick Boiling) Potato Starch

If we now compare the behaviour of ordinary, thick boiling potato starch we find the greatest possible contrast. It changes in a phenomenal way on heating, and still more on stirring (at 99° C.). Fig. 2 shows how the viscosity of a 1% paste of a good potato starch changes with the time of heating (at 99° C.). This curve is extremely characteristic; no other of the commercial starches, frequently used for sizing gives a curve comparable to the potato starch curve. Figs. 1 and 7, relating to polyvinylalkohols and

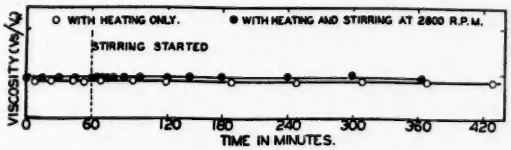

Fig. 1. Viscosity of polyvinylalcohol.

to corn starches, are drawn on the same scale. Figs. 2, 3 and 6, all related to potato starch, are drawn on a smaller scale for the viscosities, about one-fifth of the scale used for corn. Fig. 2 contains both corn and potato on the same scale, and shows how enormously more viscous potato starch is than corn starch paste.

What we first note is that the curve rises quite rapidly and steadily to a very high maximum; which means that with potato starch you can get

very high viscosity, much higher than with the sample of polyvinylalkohol described previously (much higher, also, as we will see later on, than with corn starch). But this viscosity maximum lasts only for a short time in potato starch; then it falls ending practically in a horizontal piece of the curve. This horizontal piece is especially interesting; it means that potato starch, after a certain time of heating, after it has gone through a maximum viscosity, reaches a level where its viscosity will practically not change anymore on further heating. This level is reached in our sample of potato starch in about six hours; its viscosity is then six times as high as the viscosity of thick boiling corn starch or as low as 20 fluidity thin boiling corn starch. (Compare Figs. 2 and 3 with Fig. 7, taking into account the different scales on which the curves are drawn.)

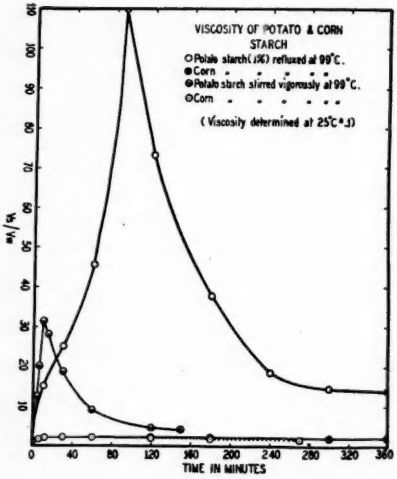
VISCOSITY OF POTATO & CORN STARCH
Potato starch (1%) refluxed at 99°C.
Corn
Potato starch stirred vigorously at 99°C.
Corn
(Viscosity determined at 25°C ± 1)
TIME IN MINUTES

FIG. 2.

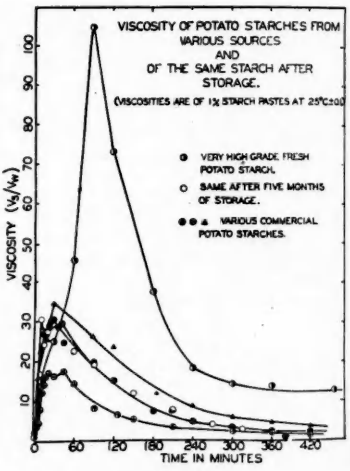
VISCOSITY OF POTATO STARCHES FROM VARIOUS SOURCES AND OF THE SAME STARCH AFTER STORAGE.
(VISCOSITIES ARE OF 1% STARCH PASTES AT 25°C±0.0
VERY HIGH GRADE FRESH POTATO STARCH.
SAME AFTER FIVE MONTHS OF STORAGE.
VARIOUS COMMERCIAL POTATO STARCHES.
VISCOSITY
TIME IN MINUTES

FIG. 3.

Now, what do we see under the microscope when we examine the starch paste at the same moment we take a sample for determining the viscosity? Something very characteristic. Till the maximum, the starch vesicles increase in size. Near the maximum, signs of breakdown of vesicles become visible; and in the following, descending part of the curve this breakdown increases rapidly. At the beginning of the flat part of the curve no starch vesicles are visible any more. They seem to have been completely dissolved. From then on the viscosity remains practically the same on further heating. There is only a very small drop in viscosity during it. We do not yet know if the starch cells are simply dissolved, or if they get chemically changed (hydrolyzed) on dissolving.

These facts clearly show that the viscosity curve is due to the overlap of two different curves (Fig. 5); the one due to a progressive swelling and hydrating of the starch vesicles, the other due to the breakdown of their

walls. The longer the heating lasts, the more the vesicle walls dissolve. The first factor increases the viscosity, the second one decreases it; the overlap of both gives the maximum. Fig. 8 shows the different stages of

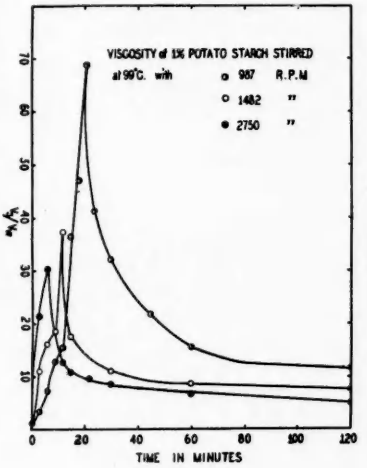

FIG. 4.

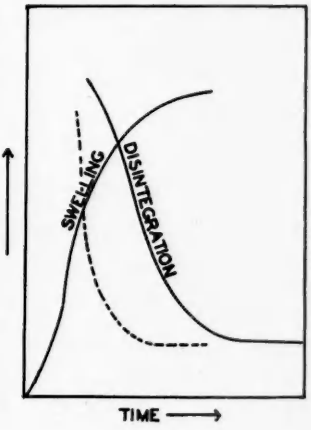

FIG. 5.

swelling and disintegration of potato starch according to microphotographs we made.

If we now use stirring and heating at the same time—stirring in differ-

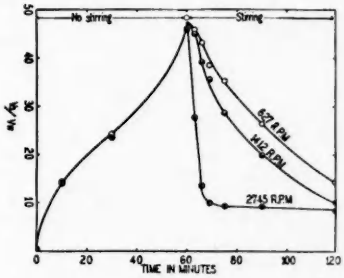

FIG. 6.

ent intensities (different r.p.m.), heating always at 99° C. (without loss of water) we get the curves shown in Fig. 4. As we see, the maximum is reached the earlier and lies the lower the more intensive the stirring is. Comparing with Fig. 5 (the dotted line) we can state without any doubt

that the breakdown and solution of vesicle walls is the faster the more intensive the stirring is; this is just what we would expect to happen. It is an old, well-known experiment, I may remind you, that a thick potato starch paste can be made waterthin by beating with an egg beater.

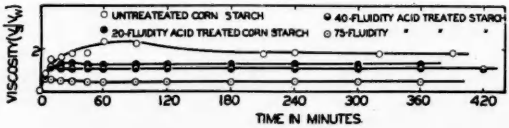

FIG. 7 Viscosity of thin-boiling corn starches.

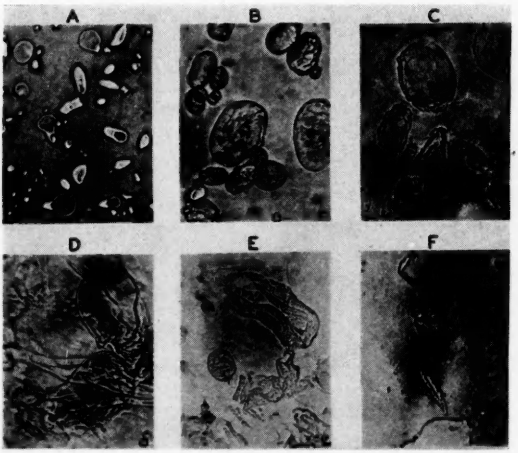

FIG. 8. Microphotographs (200 × approx.) of Potato Starch Vesicles Heated at 99° C. without Stirring.

A.—Starch suspension just after addition of hot water. Note the various stages of swelling into vesicles. No tannin was added in this case.

B.—After heating at 99° C. for 10 min. Note the increase in size, and also note the precipitate inside of each vesicle after 5% tannin solution was added.

C.—Vesicles, after the paste was heated 60 min. at 99° C. Further note swelling and some sign of breaknown becoming apparent. With tannin the vesicles still show precipitate.

D.—Vesicles, after the paste was heated 120 min. at 99° C. Note that the vesicles do not show the precipitate inside them, but outside. Here the precipitate outside is out of focus and is not very clear. Also note how clear is the breakdown.

E.—Stage of a vesicle breakdown after the paste had been heated for 240 min. at 99° C.

F.—Practically no vesicle structure left when heated for 360 min. at 99° C. The vesicle walls have broken down into small fragments.

But there is more to be learned from Fig. 4. As one clearly sees, the swelling of the vesicles, too, is favored by the stirring, and the more so the more intensive the stirring. This result was rather unexpected. I suppose it is due to a mechanical lesion of the starch granules in the moment they begin to swell to vesicles. Probably there is in a starch granule a growth structure which inhibits its swelling; and if this growth structure is hurt the granule swells faster. In Fig. 6 is shown another of our experiments about the effect of stirring on potato starch paste. It was heated 60 min. at 99° C., then stirring (in different intensities, different number of r.p.m.) was started. As a result there is a rapid drop in the viscosities; at 2745 r.p.m. an almost instantaneous drop. Yet, practically the same intensity of stirring (2800 r.p.m.) did not have any effect on the viscosity of a 1% solution of polyvinylalkohol. An extremely marked difference, is it not?

There is still one point I want to bring up about the viscosities of potato starch. Curves like Fig. 2, which determine how and how fast the viscosity of a 1% potato starch paste changes with the time of heating, are very well fitted for testing and comparing different kinds of potato starch and the way they age in the airdry condition in the warehouse. Fig. 3 shows how differently the viscosities of commercial potato starches behave after five months of keeping at about 25° C. Look at these curves and see what a blind guess a slasher man would make, when assuming that all potato starches are alike. The trade has learned by experience that potato starch should preferably be bought at a certain time of the year and stored in a cold place.

Ordinary (Thick Boiling) Corn Starches

Now, if we compare 1% pastes of ordinary corn starch we get a totally different picture (as any practical mill man would expect). Corn starch swells very much less than potato starch, but falls off very much less when kept without stirring at 99° C. It is not as good in this respect as wheat and rice starch (and as some thin boiling corn starches) which do not fall off at all; but it is pretty good. Fig. 2 shows curves on the same scale for corn and potato starches, with and without stirring. As previously noted, it shows convincingly how enormously greater is the viscosity of potato starch than that of corn starch.

Microscopical examination shows that the vesicles do not swell up very much—very much less than in potato starch. They break down rapidly, but the walls of the vesicles do not dissolve, even after 12 hours of heating at 99° C. But the vesicles are not closed any more; they open up. Here is one of the fundamental differences between corn and potato starch, which probably is, in the main, a sign of the characteristic differences between cereal starches and other starches. Stirring at 99° C. has only a slight effect on the breaking down of this corn starch, even at 2800 r.p.m. This corn starch is pretty close to the ideal of a size, in regard to breakdown of viscosity.

Unhappily, not all corn starches are as good as the one described. Other samples (see Fig. 7, the uppermost curve) show the maximum of viscosity much more pronounced than the corn starch we used for making Fig. 2. In testing of corn starches, too, it is valuable to compare how constant is their viscosity on boiling.

Let us remember that all of these experiments are made with 1% solutions, so that the question as to which of the starches is superior in a given case cannot be fully answered before we have investigated concentrated solutions.

Acid-made Thin Boiling Starches

Acid-made thin boiling corn starches are extensively used in this country. We compared samples of thick boiling corn starch with thin boiling starches of 20, 40 and 75 fluidities, all from the same firm (Fig. 7). These products proved to be beautifully standardized. The determination of the way the viscosity of a 1% paste changes with the time of heating (at 99° C.) is a fine method by which to test the extent to which a firm has been successful in standardizing its products.

From Fig. 7 we see that the viscosity in a 1% solution (as one would expect) is the lower the higher is the fluidity number given by a firm. We further see that even when the thick boiling corn starch showed a marked maximum, there is practically no maximum indicated for the thin boiling corn starches. They come pretty close, in a 1% solution, to the ideal substance whose viscosity does not change on heating or stirring.

Here, however, a reservation has to be made which applies to several other points in this report. We have only investigated here diluted (1%) starch pastes. In concentrated starch pastes, where real viscosity is difficult to measure, as previously pointed out, it has not yet been investigated as well as is needed. We hope to come back to this point in a later report.

We will, however, describe what microscopical examination taught us about these 1% pastes of the above-mentioned thin boiling starches: After about 30 min. the vesicles are entirely broken down. In the 20 fluidity starch their remains have not entirely disappeared. In the 40 and 75 fluidity starches there is nothing left of them except a very fine and stable suspension.

In doing the preceding experiments I had the valuable collaboration of Mr. W. E. Yelland and of Dr. M. C. Desai, whom I want to thank for their good help. The experiments were made at Massachusetts Institute of Technology, Cambridge, Mass., with the exception of the part made earlier at Cornell University. I want to thank Prof. E. R. Schwarz, contact man at M. I. T., for this research, for his friendly help and excellent advice.

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The Swelling of Raw and Boiled-off Silk in Relation to Width Measurement

By ROBERT V. INGRAM *

A Textile Foundation Publication

Summary

The swelling of raw and boiled-off silk was determined with reference to the diameter measurement and an inverse ratio of swelling was found. It was shown that sericin swells uniformly but that fibroin swelling depends on diameter size. Equations were deduced and a mathematical solution is given. The possible causes for this type of swelling are discussed.

Introduction

THE swelling of raw silk is a complex phenomenon which is not as yet well understood. Raw silk is composed of two substances, fibroin and sericin. Each of these substances can be further subdivided, usually by chemical means, into at least two fractions, for convenience labelled "A" and "B."[11, 12, 25, 26, 33] Thus it is seen that, at the very least, four different components enter into the swelling phenomenon of raw silk.

This study was made on raw and boiled-off silk. In the case of raw silk a split cocoon filament constituted the material for study, and for boiled-off silk, a single cocoon filament. The maximum swelling in distilled water was measured and the relationship of original diameter size to maximum swelling was determined. The terms diameter and width are used interchangeably.

Literature

Denham and Dickenson[4] have determined the lateral swelling of silk fibroin at relative humidities from 0–100%. At the 100% humidity value the fibres were immersed in water. The maximum swelling was 18.7% for Japanese silk and 16.3% for Italian silk. The swelling of silk fibroin in buffer solutions of from 1–9 pH was also observed and four minimal values for swelling were recorded at pH of 1.4, 2.8, 3.8 and 4.7. D. Jordan Lloyd and R. H. Marriott[18] studied the swelling of fibroin and silk gut and the action of acids, alkalies and salts on the swelling. Silk fibroin fibers take up about 30% of their weight of water. No work was found in the literature on the swelling of raw silk in water. H. Sobue and M. Nagano[34]

* Fellow of the Textile Foundation at the United States Testing Company, Inc., Hoboken, N. J.

have developed theoretical equations for the adsorption and desorption of water vapor on and from raw silk, among other fibres, but their work was at 40% R.H. and concerned rate of reaching equilibrium rather than actual amount of swelling. Katz,[13] in his study on the field of swelling in general, touched on silk. He pointed out the particular importance of X-ray studies in the field of swelling.

The literature on the swelling of other fibres and substances in which mention is made of silk, or which may be valuable from an analogous point of view, has been briefly touched upon. No attempt has been made to make this list complete. D. Jordan Lloyd,[17] in her work on proteins, made mention of the swelling of silk as an example of swelling restrained by structure.

In the study of the swelling of wool, M. H. Norris [29] has shown that after a treatment with alkali the wool is capable of greater swelling in water than before. Her measurement of area was made by suspending the fibre vertically and taking 15 readings at successive angles of 12 degrees. Her findings for maximum swelling in water were in good agreement with figures previously obtained. E. Gotte and W. Kling,[8] in their work on the swelling of wool, have brought out the fact that temperature shifts the curve of swelling of wool in relation to pH.

Küsebauch [15] has examined the swelling of cotton hairs in alkali (Malisch's solution. He made the very interesting observation that the increase in diameter on swelling is generally greater the finer the cotton. The literature on the swelling of cotton is very extensive. A very good review has been made by Collins.[2] Collins and Williams [3] have studied the action of water and alkalies on cotton hairs, and Urquhart and Williams [30] have studied the humidity and temperature relationships on cotton hairs. Cellulose and regenerated cellulose fibres have been examined with particular reference to swelling from various angles of approach by Küsebauch, [16] J. Tankard,[25] Hess,[9] and M. Munch.[28]

Special types of machines for use in showing the amount of swelling have been developed or adapted to this special purpose by E. Gotte and W. Kling,[8] P. Eckert,[6] K. Küsebauch,[16] M. H. Norris,[29] M. Munch [28] and J. A. Matthew.[21]

The phenomenon of swelling is so closely related to structure that a few references to the literature of the fine structure of silk are in order. K. Ohara [20] has made a study entitled the "Submicroscopic Structure of Silk." He has examined the phenomena of dichroism, refractivity and swelling in a dispersion medium. A. Frey-Wyssling [7] has demonstrated the existence of a submicroscopic capillary system in fibres by precipitating particles of gold and copper into these spaces.

Y. Matsunaga,[22] by means of a vacuum X-ray camera, had demonstrated that intramicellar swelling occurs in silk. P. P. von Veimarn,[33] from an ultramicroscopic study of the dispersion of silk, concludes that silk splits into fibrils of 200 μ length. T. Lonsdale [19] postulates an internal pore structure for silk from moisture regain and swelling data plus similarity to wool which is known to have a pore structure.

Method of Measurement

The silk is affixed to a glass slide, under known tension after a soaking treatment in distilled water.

The image of the silk filament is projected onto a ground-glass screen at 500 diameters magnification and measured in microns directly by a transparent scale.

Material and Treatment of Material

The cocoons from which the silk was taken were autumn-white (1936) from Dyogo, Japan. In the process of drying the cocoons were subjected to a minimum temperature of 140° F. and a maximum of 205° F. They were stored five months previous to shipment to this country. The following procedure was used in preparation of the specimen. About 20 yds. of filament were stripped from the selected cocoon. The cocoon was then boiled in water for about two minutes. Then cold water was dashed on it to make the cocoon fill with water and sink.[39] This procedure is known as the "sunken method" of reeling. It was used to soften the sericin so that the filament would come from the cocoon in the most uniform condition possible. The time of boiling was considerably reduced from that in commercial practice. The cocoon filament was then taken from the cocoon in one continuous strand. The filament was immediately split, while still damp from the cocoon, by means of a pick needle and use of a low power binocular microscope. The split cocoon filament was wound on a card, and both halves are used in the experiment.

For boiled-off silk the procedure was the same up to the point of splitting the filament. Instead, it was attached to a 16 in. diameter reel and about half of the reelable silk was reeled off and made into a skein. This skein was boiled-off in two successive baths of 1% neutral soap solution for one-half hour each. The temperature of the bath was adjusted so that the boiling would be as gentle as possible to avoid tangling the skein. Every five minutes the skein was turned on a glass rod to insure perfect penetration of the solution to all parts of the skein. Between baths and after the second bath, the skein was rinsed in three changes of distilled water. Also after the second bath there was an additional rinse in hot distilled water and then in 95% ethyl alcohol to take out the last traces of soap. Then there were three successive rinses in hot distilled water to remove any traces of alcohol. The skein was then air dried at room temperature.

From this point both raw and boiled-off silk were handled identically. They were subjected to a relaxing treatment, suggested by Dr. A. C. Walker[39] of Bell Telephone Laboratories. The procedure was as follows: Lengths of filament of from 12 to 16 ins. were immersed in distilled water at room temperature for five minutes. They were then removed from the water and allowed to dry in air for 15 minutes. This process was repeated ten times. In water the filament was not under tension, but while drying a tension approximately equal to 0.1 g. was applied to the filament. Filament so treated was not used in the experiment until after a 24 hour period had elapsed in which the moisture in the fibre could come to complete equilibrium with the moisture in the atmosphere.

Experimental Procedure

The next step was the fastening of a short section of the split filament to a glass slide, 1 in. × ¾ in. This was done with two small drops of cellulose cement. The filament was cemented across the width of the slide under a definite tension. About ½ in. of split filament was free for examination between the drops of cement. The tension was produced by a weight of 0.4 g. acting through gravity. The second drop of cement was applied and allowed to dry while the tension was still applied. As a weight well within the elastic limit of the split cocoon filament 0.4 g. was selected. The slide

was placed in a cell whose inside dimensions were 1 by ¾ by ⅜ in. The cell had two plain parallel transparent faces. To one of these the back of the slide was attached by the capillarity of a small drop of distilled water. The projection apparatus on which the cell was placed has been described by Mennerich.[24] It consisted of a micro-projector which was strongly illuminated through a substage condenser with light from a suitable ribbon filament Mazda bulb. The magnified image of the silk filament was projected horizontally onto a ground glass screen. The apparatus was so arranged that the image of the filament appeared on the screen at 500 diameters magnification. The observer sat behind the screen and took measurements with a transparent glass scale calibrated directly in microns. Individual measurements were read to the nearest whole micron. The average maximum error of a single reading was less than 10%.

Two different types of measurements were made; namely, in air and in water. It must be definitely pointed out that during the course of the experiment there was no control over the humidity of the atmosphere and the temperature.

At least 50 diameter readings were made, in air, along the entire exposed length of the filament attached to the slide in order to arrive at an average diameter for the specimen.

Then a field was picked in which the filament appeared as uniform as possible and 10 measurements were made across it, in air, at stated intervals. Distilled water was then added to the cell by means of a pipette, the filament refocused if this were necessary and readings were taken in the same places as before.

The average of the readings in air was subtracted from the average of the readings in water and the percent swelling calculated.

Limitations and Sources of Error

This study was made on one sample of cocoons only. This sample is representative of one season, one locality, and one strain of bombyx mori. However, there is no reason to suppose that it cannot be taken as representative of the cocoon silk of Japan.

Magnification to 500 diameters introduces an error due to spherical aberration at the edge of the magnified field. This error was calculated to be of the magnitude of 0.75% as applied to our average results, and individually was at all times much less than the smallest unit of measurement.

The study should have been made in a controlled humidity atmosphere. It would have been greatly improved by taking of the "air" values at a known humidity. The readings were taken in the winter in a heated building where it may be presumed that the humidity was quite low. The temperature, which was about 70° F., also should have been held constant.

Denham and Dickenson[4] have found a longitudinal swelling in silk of 1.3%. In our work this swelling and its effect has been entirely disregarded. A particular source of error is the increase in length which might have caused a twist in the filament, thus presenting a shorter or longer diameter than that originally measured.

In the splitting of the raw silk filament the sericin in places presents a very irregular surface. Particular attention was paid to this source of

error, for every specimen was carefully examined and the most uniform area selected for test.

There were a few average results which showed a contraction of size where a swelling would naturally be expected. The only explanation fitting the case was that the filament twisted, presenting a lower diameter even when swollen. But there were a number of excessive swelling values obtained which were believed to be due to twists to a larger diameter. As these values would tend to average themselves out, all were retained in the study.

Experimental Results

The average specimen diameters for raw split cocoon filament were averaged and the standard deviation of the average calculated. The same was done for boiled-off cocoon filament.

All readings are given in microns:

Filament	Average	Standard Deviation	Number of Measurements
Raw (Split)	14.02	0.92	5608
Boiled-off	11.88	0.54	5974

The percent diameter swelling was found to be as follows:

Filament	Percent Swelling	Standard Deviation	Number of Measurements
Raw (Split)	32.96	10.49	3520
Boiled-off	16.38	10.44	4100

The individual readings on which the percentage swelling was calculated were analyzed with the following results:

Filament	Medium	Average	Standard Deviation	Number of Measurements
Raw (Split)	in air	13.92	3.13	1760
Raw (Split)	in water	18.41	4.02	1760
Boiled-off	in air	12.29	2.26	2050
Boiled-off	in water	14.20	2.36	2050

The individual readings, in air, on which the percentage swelling was calculated, were grouped according to measurement; *i.e.*, all readings of 8 microns were grouped together, all readings of 9 microns were grouped together, etc. Then the corresponding readings in water were handled in the same way; *i.e.*, all readings in water whose readings in air were 8 microns were grouped together, and all readings in water whose readings in air were 9 microns were grouped together, etc. These groupings were each averaged and the percent increase calculated. The standard deviation and standard error (standard deviation divided by the square root of the number of determinations) were computed. All of the results for raw split cocoon filament are compiled in Table 1, and for boiled-off cocoon filament in Table 2.

In Graph 1 the data on raw split cocoon filament measured in air are plotted against the data measured in water. An apparently linear relationship is revealed. The equation which expresses this relationship is

TABLE 1

Raw Split Cocoon Filament

Air Diameter Average	Number of Measurements	Water Diameter Average	% Increase	Standard Deviation	Standard Error
8	23	12.61	57.63	2.05	0.43
9	74	14.21	57.89	2.41	0.28
10	120	14.39	43.92	2.28	0.21
11	157	15.34	39.45	2.20	0.18
12	235	16.50	37.50	2.30	0.15
13	254	17.17	32.08	1.73	0.11
14	221	18.25	30.36	2.11	0.14
15	189	19.49	29.93	2.32	0.17
16	166	20.38	27.38	2.60	0.20
17	94	21.49	26.41	2.43	0.25
18	76	22.47	24.83	2.51	0.29
19	47	23.81	25.32	2.05	0.30
20	37	25.84	29.20	2.47	0.45
21	31	25.71	22.43	2.52	0.45

$y = 1.03\,x + 4.40$, in which y is measurement of diameter in microns in water and x is measurement of diameter in microns in air. The coefficient of correlation was calculated to be 0.81, a figure which shows definite relationship. In graph 2 the data of boiled-off cocoon filament for measurement in air are plotted against the data for measurement in water. Again a linear relationship was found. The equation for boiled-off filament is $y = 0.79\,x + 4.45$, and x and y have the same designations as before. The coefficient of correlation was found to be 0.78.

For purposes of comparison only, the average values of Tables 1 and 2

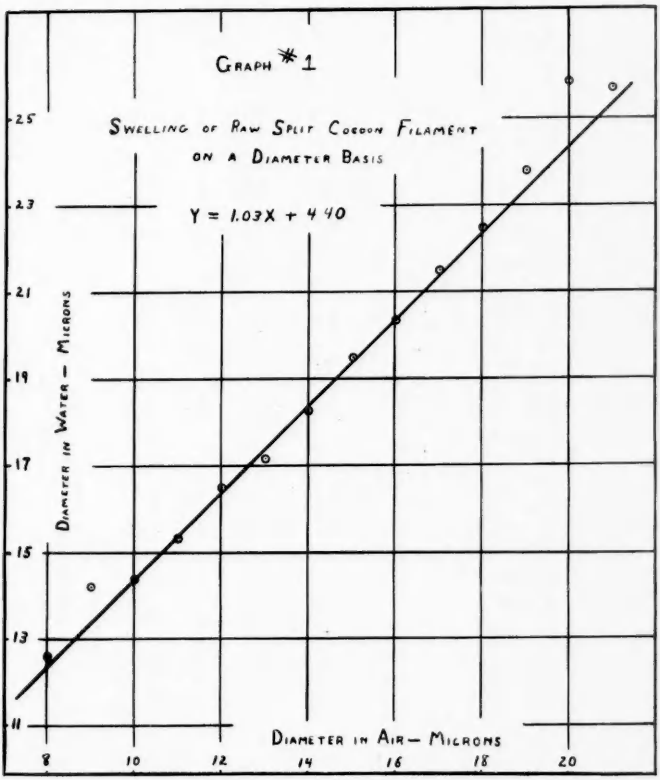
TABLE 2

Boiled-off Cocoon Filament

Air Diameter Average	Number of Measurements	Water Diameter Average	% Increase	Standard Deviation	Standard Error
8	29	10.83	35.25	1.95	0.36
9	183	11.63	29.22	1.52	0.11
10	291	12.29	22.90	1.35	0.08
11	327	13.07	18.82	1.52	0.08
12	241	14.02	16.83	1.40	0.09
13	354	14.81	13.92	1.26	0.07
14	259	15.46	10.43	1.30	0.08
15	204	16.50	10.00	1.60	0.11
16	86	17.05	6.56	1.89	0.20

were converted into circular area (square microns) by use of the formula $\pi d^2/4$. These values were handled in the same manner as in Graphs 1 and 2. Apparent linear relationships were also found which are expressed by the following equations:

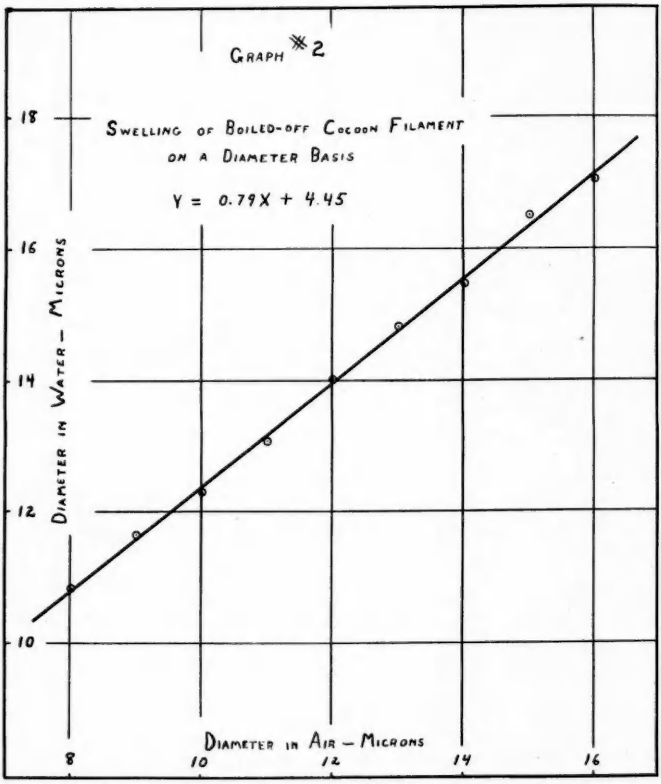
Raw (split) cocoon filament.....S = 1.335 R + 57.57
Boiled-off cocoon filament.....S = 0.92 R + 47.47



S stands for area in square microns in water and R is area in square microns in air.

It is recognized that the outline of the cross-section of a silk filament is not circular. The use of these equations and any results of data calculated into circular area is for purposes of comparison only. This would appear to be permissible as these calculations are based on averages and

not single measurements. Further W. S. Denham and E. A. Hutton, working with Italian silk, have shown that there is a valid proportionality factor between mean width and mean cross-sectional area. This factor they have calculated to be 0.84.



Interpretation of Results

Silk cocoon filaments both raw and boiled-off, swell in a ratio inversely proportional to their diameters. Since both raw and boiled-off silk were studied, it is possible to draw some deductions concerning sericin. If the average diameter figures for raw silk filament (split) and boiled-off filament are converted to area on the basis of a circular cross-section, it is found that 22% of the area is lost by boiling-off. A careful search of the literature failed to disclose any direct measurement of the density of

sericin. However, from a comparison of density figures for raw and boiled-off silks,[14, 27, 31, 37] it is deduced that the specific gravity of sericin is quite close to that of fibroin. For purposes of comparison they will be assumed to be the same. It is known that the average amount of sericin on the raw silk fibre decreases gradually from the outside to the inside of the cocoon. In this study it is assumed that the decrease is very small and it will be disregarded. Kaneko sets the amount of sericin on cocoon filament at about 25%. Our calculated figure of 22% is in fair agreement with this value. For purposes of comparison the figure of 25% sericin was used. The swelling of sericin is independent of original diameter size and amounts to 230% on a diameter basis. This is in direct contrast to fibroin, as will be shown later. The swelling of sericin was calculated on filament diameters from 8 to 16 microns in width in accordance with the equations for swelling derived from the data, and the percent swelling was found to be a constant for all diameters covered.

In contrast, the swelling of fibroin depends upon the original diameter size; the range from 8 to 16 microns diameter falls from 143% to 111% and is a variable quantity. The constants of the diameter swelling equations appear to lie in the fibroin portion of silk. A careful survey of the literature on the submicroscopic structure of fibroin failed to give any clue which might explain the nature of the constant. It is known from X-ray diffraction studies[1] that silk fibroin substance can be divided into two general headings: namely, crystalline and non-crystalline. It seems reasonable to assume that the swelling of these two components will be different. A case can even be made out for no swelling in the crystalline component due to lack of change in the X-ray diagram from dry to wet state.[22] However, the orientation of the crystalline state seems to control the amount of swelling of which the non-crystalline portion is capable, as shown by the fact that regenerated fibres in which the crystallites are less uniformly oriented have a greater degree of swelling.[20]

Another complex factor in the swelling of fibroin is that the slope of the curve is less than one. According to this, there is a point at which silk fibroin has no swelling. This point is beyond the highest values obtained experimentally and therefore is a theoretical one.

A mathematical analysis of the equation for fibroin was suggested by Dr. H. F. Schiefer of the National Bureau of Standards. Assume for the moment that the non-swelling portion of the fibre is a central core. Let $D =$ the diameter of dry silk, $b =$ the diameter of the core and $a =$ the diameter of the material surrounding the core—the material which swells. Then $D = a + b$. Let $W =$ the diameter of wet silk. Then $W = ma + b$, m being the swelling factor. Combining the above equations, $W = mD + b(1 - m)$. Since m must be greater than one if the silk swells, the factor $b(1 - m)$ must be negative. Assume that the diameter of the core bears a linear relation to the dry diameter of the silk: $b = KD + C$. Then $W = D(m + K - mK) + C(1 - m)$. This equation would fit the experimentally derived equation under the following conditions: K must be positive, C must be negative, and the data must all be between $W = D$ and $W = mD$.

In the above analysis there is nothing to indicate the arrangements of the two components. The argument would hold just as well if they were simply a heterogeneous mixture and X-ray analysis favors this picture.[32]

On the other hand, something can be said for the core theory. If it is assumed that the outer layer of silk fibroin, as it absorbs water, closes the pores and retards or even stops the penetration of water, then the observed effect becomes explicable. If the diameter of the pores diminish toward the center of the fibre, making a denser center[20] and become smaller than the diameter of a water molecule so that the water is unable to proceed further into the fibre, the same holds true. In these cases fine silk will swell more in proportion than coarse silk which would agree with experimental results.

Because in each case the deductions are based on assumptions no definite conclusion can be drawn without further knowledge of the silk fibre and this of course demands much further research work upon silk.

Cross-Sections

An attempt was made to study the swelling of silk on thin cross-sections. These sections were cut from silk frozen into a small block of ice on a freezing microtome. The technic proved to be extremely difficult from a manipulative angle. The chief difficulty lay in the fact that the knife would bend the fibre over, rather than cut it. Sections were also cut at the wrong angle, which would introduce difficulties. Only a very few good thin cross-sections were secured and these showed the same type of swelling that had already been observed on longitudinal mounts. Because of the lack of results after careful preparation, this method was abandoned.

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I. Fibres (Synthetic and Natural) and Fibre Analysis

Cotton Fibres: Growth and Structure of. D. B. Anderson and T. Kerr. *Ind. Eng. Chem.*, Jan. 1938, P. 48–54; abs. in *Paper Trade J.*, April 28, 1938, P. 89.

From observations carried out on the Mexican Big Boll variety of American upland cotton (*Gossypium hirsutum*), it is concluded that a number of the observations made upon cotton fibre walls cannot be accounted for by the ellipsoidal particle hypothesis, while the miscellar hypothesis appears to satisfy all of these observations. (C)

Cotton Fibres: Studies in the Variation of Strength and Weight per Inch with Group Length of. C. Nanjundayya and N. Ahmad. *Indian Central Cotton Committee Technological Laboratory, Technological Bulletin Series B*, No. 24, April 1938; *J. T. I.*, May 1938, P. T75–T110. (C)

Degumming of Ramie. L. Pauley. *Tiba*, 1937, V. 15, P. 151; abs. in *Am. Dye. Rptr.*, May 2, 1938, P. 251.

The paper describes in detail the approved methods of preparation of the fibre by caustic alkalies, ammonia and sulfite, and trisodium phosphate, with many practical details and comments (C)

EQUILIBRIUM MOISTURE CONTENT OF SOME TEXTILE MATERIALS. E. K. Strachan. *Am. Dye. Rptr.*, May 2, 1938, P. 240–2.

Paper presented at meeting, Rhode Island Section, A. A. T. C. C., Mar. 25, 1938. (C)

FIBRES OTHER THAN WOOD USED IN PAPER MANUFACTURE: IDENTIFICATION OF. F. F. Wangaard. *Paper Ind.*, 1937, V. 19, P. 777–84 (through *C. A.*, 1938, V. 32, Col. 773); abs. in *J. T. I.*, March 1938, P. A129.

A description of the microscopic features valuable for the identification of the following non-woody fibrous materials used in the production of paper: Cotton, flax, ramie, hemp, mitsumata, jute, sugar cane, corn, bamboo, esparto, rice, rye, barley, oat, wheat, manila hemp and New Zealand flax. (C)

FINE FILAMENT RAYON: PRODUCTION OF. I. "CLASSIC." *Silk & Rayon*, May 1938, P. 462, 464, 466. (C)

HIGHLY POLYMERIZED COMPOUNDS. 180. DEGREE OF POLYMERIZATION OF CELLULOSE IN VARIOUS SPECIES OF WOOD. H. Staudinger, E. Dreher and I. Jurisch. *Ber.*, Dec. 1, 1937, P. 2502–7; *B. I. P. C.*, V. 8, P. 134; abs. in *Paper Trade J.*, April 28, 1938, P. 90. (C)

HIGHLY POLYMERIZED COMPOUNDS. 181. CELLULOSE SOLUTIONS. H. Staudinger and G. Daumiller. *Ber.*, Dec. 1, 1937, P. 2508–13; *B. I. P. C.*, V. 8, P. 182; abs. in *Paper Trade J.*, April 28, 1938, P. 90.

From viscosity determinations of celluloses of various origins in different solvents it is found that solutions of cellulose of the same concentration have different specific viscosities in different solvents. The celluloses are dissolved in all the solvents used in the same way. (C)

HIGHLY POLYMERIZED COMPOUNDS. 182. NOTES CONCERNING THE MICELLAR THEORY OF CELLULOSE BY TH. LIESER. H. Staudinger. *Ber.*, Dec. 1, 1937, P. 2514–7; *B. I. P. C.*, V. 8, P. 134; abs. in *Paper Trade J.*, April 28, 1938, P. 90.

In a polemic against Th. Lieser's miscellar theory of cellulose, the author claims that the term "micell" should be used for cellulose in its solid state only. The colloid particles in dilute solutions of cellulose and its derivatives are macromolecules. The crystalline parts of the solid cellulose are crystallites which have a macromolecular lattice. Such a crystallite may be termed "micell" according to Nägeli. (C)

INDIAN COTTONS: STAPLE LENGTH AND YARN COUNT RELATIONSHIP. N. Ahmad and V. Venkataraman. *Indian Text J.*, 1937, V. 48, P. 51; abs. in *J. T. I.*, March 1938, P. A165.

The equation $L = 0.6 + 0.009\ C$ reproduces results of laboratory spinning tests on Indian cottons of staple length (L) 0.6 to 1 inch spun to standard lea strengths (tabulated) in medium twists and counts from 6s to 40s. It has been found, however, that the laboratory results are about 15% above mill results and therefore the equation is corrected for practical spinning to $L = 0.6$ to $0.0104\ C$. A calculation of staple length for a required count from this equation gives the result in hundredths of an inch (*e.g.*, 0.81 in. for 30s warp). A table is provided for the conversion of these lengths into 32nds of an inch, and a final column of figures includes

a correction for the fact that the staple length as determined in the laboratory and calculated from the equation is about 0.03 in. less than the grader's estimate. (C)

II. Yarns and Fabrics

Andrew and Langstreth Disc Doubler. Improved Supply Package Carrier Inc. *Text. Recdr.*, July 6, 1938, P. 40–1.

The object of the machine, when used in connection with the production of tire cords, is to twist the yarn, usually five-fold on the cheese, into a yarn suitable for the next process of cabling at the ring doubler. The outstanding feature of the machine is the unorthodox method by which twist is inserted into the yarn. The yarn is twisted by means of a rotary disc which also serves to guide the yarn in the form of a loop. The effect of the loop formation is that one leg of the loop rotates round the other, so that for one revolution of the disc, two turns are put into the yarn. Consequently, neither supply package nor delivery package is actually rotated to insert twist. (C)

Clothing: On the Reflection Factor of. Parry Moon and M. S. Cettei. *J. Optical Soc. Am.*, 1938, Vol. 28, No. 8, P. 277–9.

In the modern development of illuminating engineering, a need is sometimes felt for data on the reflection factor of clothing. The present article deals with data obtained by means of the Hardy color analyzer at M.I.T. on a series of several hundred samples of men's wear. For statistical purposes, it may be stated that the average man in the United States wears a neutral gray suit having a reflection factor of 4.5%. This reflection factor is essentially the same for light from all types of lamps. The total range of reflection factors for overcoats and suits, excluding white material, appears to be from approximately 1.6 to 16%. Comparisons with results obtained in Holland indicate that the clothing worn there is perhaps darker than that used in the United States. The article should be of interest to those who are concerned with the reduction of highway accidents to pedestrians and particularly to those whose business it is to furnish the clothing worn by the man on the street. (S)

Dry Cleaning of Acetate Rayon. K. Rickert. *Deut. Färber-Ztg.*, 1937, V. 73, P. 603–4; abs. in *C. A.*, 1938, V. 32, Col. 1940. (W)

Drying of Linen: Theory of. Otto. Th. Koritnig. *Deut. Färber-Ztg.*, V. 74, No. 1; *Prakt. Neuerung. Erfahrung. ges. Textil-Vered lungs-Ind.*, No. 47, P. 188 (1938); abs. in *C. A.*, 1938, V. 32, Col 2363.

The artificial drying of linen is satisfactory only if it imitates the natural process of drying on meadows and lawns. The linen must be spread out so as to offer the greatest surface to heat and air. Both surfaces must be exposed. Moist heat must be used instead of dry heat. Proper drying installations are described. (W)

Fast Drying in Film Printing of Textiles. Albert Franken. *Klepzig's Textil-Ind.*, 1938, V. 41, P. 78–9; abs. in *C. A.*, 1938, V. 32, Col. 3157.

Attempts to accelerate drying by ordinary air-conditioning methods were not successful. Chem.-drying methods using concd. H_2SO_4 or $CaCl_2$ cannot be used in film printing textile plants. Drying of the air by adsorption on silica gel was fully successful. The gel can be regenerated by heat-

ing in an air current at 120°. In practical tests the goods were dried quickly and completely even under the most unfavorable atm. weather conditions without increasing the temp. of the room above 20°. The app. required is simple in construction and easy to operate. (W)

HAND-SPUN HARRIS TWEED WOVEN IN HARRIS. MANUFACTURE OF HARRIS TWEED ON THE OUTER HEBRIDES ISLANDS. K. Hentschel. *Klepzig's Textil-Z.*, 1938, V. 41, P. 2–7; abs. in *C. A.*, 1938, V. 32, Col. 1940.

A detailed review of manuf. and chem. and phys. treatments. (W)

ELASTIC AND FATIGUE PHENOMENA IN YARN SUBJECTED TO TENSILE STRAIN. K. Küsebauch. *Mell. Textilber.* (German ed), 1938, No. 8, P. 629.

Yarns are exposed to alternate tension and relaxation during weaving, and the term hysteresis is used to express that strain and its after-effect. Fatigue is regarded as the loss of elasticity after having been exposed to repeated strain. The author examines the behavior of yarns when exposed to tensile strain and describes a method by which hysteresis can be calculated from the load and relief curves. Mercerized yarn shows greater signs of fatigue than does ordinary cotton yarn. The symptoms of fatigue shown by a large number of yarns that have been exposed to various treatments have been experimentally determined and the results are discussed in the present article. (C)

"HAYES-GRATZE" PROCESSES FOR RETTING OR "COTTONIZING" VEGETABLE FIBRES. H.–G. Products Ltd. *Text. Mfr.*, June, 1938, P. 239, 257.

Flax, ramie and phormium tenax retting, decortication, and the "cottonization" of these and hemps, by these processes is based on the use of sulphonated ionized vegetable oils or gels. (C)

HEAT-RETAINING PROPERTIES OF GARMENTS. Otto Mecheels. *Mell. Textilber.* (German ed.), 1938, No. 5, P. 423.

In cooperation with the textile engineers Messrs. *Weeke* and *Mees*, extensive experiments were carried out in a new wind tunnel upon the heat retaining properties of garments. It was found that that property is mainly to be ascribed to the specific heat conductivity of the fibres used and their ability to maintain a layer of air between the body and the outer air. The specific heat conductivity of fibres can be modified by the finish and by chemical agency. The layer of air retained around the human body has a specially heat retaining effect when it is kept as thick as possible and not much circulation takes place. The thickness of the layer of air and the prevention of circulation can be influenced to a great extent by the set of the cloth, milling, raising, and other processes. All measurements of the heat retaining properties of garments must be connected with a measurement of their permeability by air and their weight per square yard. (C)

LANITAL PRODUCTION. *Text. Wld.*, May 1938, P. 78–9.

Illustrations show steps in manufacture of synthetic fibre from casein. (C)

MOTHPROOFING PROBLEMS. W. C. McTavish. *Soap* (Sanitary Products Sect.), 1938, V. 14, No. 1, P. 103–5; abs. in *C. A.*, 1938, V. 32, Col. 1941.

The efficiency for the different types of chemicals used for clothes-moth control is discussed and a detailed review of some of the literature is

given. The clothes-moth larva differs from most insects in its ability to digest the keratin of wool, and M. believes that future work should take this into consideration and that much past work can be explained by this fact. From the work of Linderstrom-Lang and Duspiva (*C. A., 30,* 737) it appears that the presence of a thiol in the intestinal secretion renders wool susceptible to attack by proteolytic enzymes. If wool could be treated with a chemical which upon ingestion would oxidize the thiol compds. before they reduced the wool, the larvae would starve to death. The toxicity of thio-urea compounds may be explained on this basis. Nine references. (W)

PIECINGS IN OPEN (BRADFORD SYSTEM) DRAWING. H. D. Walker. *Text. Recdr.*, July 6, 1938, P. 25–6.

A practical discourse on the defects caused by the faulty joining of slubbings during the creeling operation. (C)

III. CHEMICAL AND OTHER PROCESSING (NOT OTHERWISE CLASSIFIED)

PERMANENT FINISHES. F. A. Lucy. *Text. Age.*, Sept. 1938, P. 41, 44–6.

Permanent finishes for textiles are described as largely in the embryonic stage. (C)

PIECE-DYEING IN RELATION TO CARBONIZING. Anon. *Wool Record & Text. Wld.*, Sept. 1938, P. 30–1, 37–40. (C)

RAYONS: CRUMPLING (CRUSHING) STRENGTH OF. E. Elöd and P. Etzkorn. *Angew. Chem.*, 1938, V. 51, P. 45–52; abs. in *C. A.*, 1938, V. 32, Col. 3970.

Exptl. results are reported. The micellar stretching theory could not be substantiated. Rayons with high-swelling capacity possess increased crumpling tendency. The improved crumpling resistance obtained by impregnation with solns. of artificial resins is greatly dependent upon the particle size of the precondensation products and the kind of distribution of the resin in the fibre layers. Diagrams, photomicrographs and nine references are given. (W)

REVERSIBLE POLYMERIZATION AS THE CAUSE OF A NEW TYPE OF ABSORPTION BAND OF DYES. G. Scheibe. *Kolloid-Z.*, 1938, V. 82, P. 1–14; abs. in *J. Soc. Dyers Col.*, April 1938, P. 182. (C)

SCREEN PRINTING. J. S. Wheelwright. *J. Soc. Dyers Col.*, July 1938, P. 319–22.

Discusses various methods of screen printing, including a mechanical process developed by the author which is largely automatic in operation. (C)

SOAPING OF CHROME MORDANT COLOR PRINTS. I–II. "TECHNICUS." *Text. Mfr.*, 1938, July, P. 294–6; Aug., P. 342, 347.

Some of the difficulties in obtaining soft and clear results; methods suggested for overcoming them. (C)

Swelling Phenomena of Rayon and Staple Rayon Caused by Alkalies: An Attempt to Explain the. Max Münch. *Klepzig's Textil-Z.*, V. 41, P. 180–1; *Spinner u. Weber*, V, 56, No. 1, P. 8; *Deut. Textilwirt.*, V. 5, No. 6, P. 9–10; *Deut. Wollen-Gewerbe*, V. 70, P. 272 (1938); abs. in *C. A.*, 1938, V. 32, Col. 3969. (W)

(New) Textile Chemistry. A. J. Hall. *Canadian Text. J.*, Sept. 2, 1938, P. 29–31.

Recent developments in textile auxiliaries: their nature and application in processing. (C)

(From) Turkey Red to Alizarine Red. R. Haller. *Mell. Textilber.* (German ed.), 1938, No. 5, P. 448.

The author deals with the history of the development of dyeing with alizarine red lake and the theory of the process, including a critical analysis of the extensive literature on this subject. Deep insight is afforded into the complicated chemism of the alizarine red lake and its methods of production, and much light is shed on the process, which still presents many puzzling features. The author is of the opinion that every investigator in this field has come a little closer to the truth. Although the genesis of Turkey red and its means of dyeing are still fairly obscure, Prof. Haller views the goal of completely clearing up the riddle of the formation of the red lake as lying in the future. (C)

Uneven Dyeings in Cotton and Rayon Velvet. Bedu. *Klepzig's Textil-Z.*, 1938, V. 41, P. 50; abs. in *C. A.*, 1938, V. 32, Col. 2359.

Unevenness of dyeing may be caused by variations of the moisture content of the textile. After the singeing, the more humid portions of the fabric contain long fibres which absorb larger amts. of dye. Similar results are obtained if the nap contains unequal lengths owing to non-uniform shearing. A short nap absorbs less dye than a longer nap so that the former appears lighter and the latter darker. Uneven dyeings may be due also to insufficient desizing, which causes some fibres to stick together and offer greater resistance to singeing than do those fibres from which the size has been removed completely. (W)

Uneven Dyeing with Indigosols. Bedu. *Klepzig's Textil-Z.*, 1938, V. 41, P. 158; abs. in *C. A.*, 1938, V. 32, Col. 3620.

Prerequisites of good dyeing results are the thorough preliminary desizing as well as the use of highly-sol. indigosol dyes. The addn. of insufficient amts. of Glauber's salt leads to poor results because of salting-out effects. The dyeing operation should be begun at high temp. and concluded at low temp. For slightly sol. indigosols the min. temp. (depending upon the dye concn. and salt addn.) should not be passed. Uneven dyeing results also when the dyeing is not developed immediately. If rapid development is impossible then the dyed goods should either be dried rapidly or else protected against light and acid vapors by being covered with cloth that had been wetted with the dyeing liquor. (W)